NMSU Agricultural Modernization: Biomedical Research Facility **EXPANSION**

95% Construction Documents (Owner Review)
Date: December 4, 2023

PROJECT MANUAL

New Mexico State University
1780 E University Ave
Las Cruces, NM 88003

fbt | architects

SECTION 00001 - CERTIFICATION

The technical material and data contained in this Project Manual were prepared under the supervision and direction of the undersigned, whose seal as a Professional Architect, licensed to practice in the State of New Mexico, is affixed below.

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Section F. Purchases of Construction and Related Services

1. Applicability. The terms and conditions in this section F apply only to purchases of construction and related services.

2. General Provisions:

(a). *Definitions*:

(1). *Addendum or Addenda*. A change or changes to the Proposal Requirements issued by the Project Architect prior to proposal due date.

(2). *Approved and Directed*. Approved and directed by the Project Architect.

(3). *Best, Good, and Proper*. The best possible and most workmanlike manner and using the best materials known to the trade.

(4). *Change Order*. A written order from the Project Architect or RCM to the Contractor issued after execution of the Contract authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. In order for a Change Order to be fully executed, it must be signed by Contractor, RCM and the Project Architect, if retained for the Project.

(5). *Contract*. An Agreement between NMSU and Contractor regarding the Work including Purchase Orders.

(6). *Contract Documents*. The Purchase Order, all additional documents included by reference therein, and all Addenda and Change Orders. The additional documents may include, but are not limited to: the Contract, Standard Terms and Conditions, completed Bid Form or Proposal Form, Notice to Proceed, Drawings, and Specifications.

(7). *Contract Sum*. The dollar amount stated in the Contract, Purchase Order, or that amount as modified by Change Order(s), including the Base Proposal, awarded Proposal Lots, Additive Alternates, and applicable Unit Prices.

(8). *Contract Time*. Unless otherwise provided, the period of time allotted in the Contract Documents from date of Notice to Proceed to Substantial Completion of the Work, including authorized adjustments thereto.

(9). *Contractor*. The Seller whose proposal is accepted by NMSU and with whom a Contract is entered.

(10). *Drawings*. All plans, details, sections, elevations, and other drawings under title of this Project.

(11). *Furnish*. To supply and deliver to the Project site, ready for installation.

(12). *Install*. To place in position, ready for service or use.

(13). *New Mexico Gross Receipts Tax (NMGRT)*. New Mexico Gross Receipts Tax includes all other applicable local options taxes.

(14). *NMSU or Owner*. The Regents of New Mexico State University and their agents, representatives and assigns. The term "Owner" may be used in the technical specifications sections of the Contract Documents to mean NMSU.

(15). *Notice to Proceed*. Written notice to Contractor from the RCM to begin performance of the Work required by the Contract Documents.

(16). *Product Data*. Illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by Contractor to illustrate materials, product or system for some portion of the Work.

(17). *Proposal Documents*. Invitation to Bid or Request for Proposals, Advertisement for Bids or Proposals, completed Bid Form or Proposal Form, the Bid or Proposal, and other information that may be provided to facilitate the Invitation to Bid or Request for Proposals.

(18). *The Project*. Total construction effort related to the Work. The Work may be all or a part of the Project.

(19). *Project Architect*. A person licensed to practice architecture in New Mexico, or an entity lawfully practicing architecture in New Mexico who is engaged by NMSU as its representative for management of the work. The University Architect may be designated as the Project Architect.

> (A). *Architect or Engineer*. When used alone and without further modification, the term "Architect" means the Project Architect. Frequently in the technical specifications the Architect is referred to as the Engineer. For purpose of project management, the term "Engineer" may also mean the Project Architect.

(20). *Provide*. To furnish and install, complete and ready for intended use.

(21). *RCM.* NMSU Representative for Contract Management who is NMSU's designated representative for management of the Work if no project architect is retained. The RCM will oversee the project architect if a project architect is retained for management of the work. For purposes of these terms and conditions the term Project Architect will mean RCM if a Project Architect is not retained.

(22). *Samples*. Physical examples which illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

(23). *Shop Drawings*. Drawings, diagrams, schedules and other data specially prepared for the Work by Contractor or any Subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.

(24). *Specifications*. The written, qualitative requirements for products, materials, and workmanship, as well as written procedural and administrative requirements of the Work. All Sections of the applicable Project Specifications using the Construction Specifications Institute's MasterFormat (Divisions 1 through Division 49) are Specifications.

(25). *Subcontractor*. A person or entity that has a direct or indirect contractual relationship with Contractor to perform any of the Work.

(26). *Substantial Completion*. When the Work, or designated portion thereof, is certified in writing by the Project Architect or RCM as sufficiently complete, in accordance with the Contract Documents, so NMSU can occupy or utilize the Work or designated portion thereof for the intended use.

(27). *Substantial Completion Date*. The date when Substantial Completion is achieved.

(28). *University Architect*. The person licensed to practice architecture in New Mexico and employed by NMSU as its immediate representative for planning, design, construction and related projects. The University Architect may function as the Project Architect for in-house and other projects.

(29). *The Work*. Construction required by the Contract Documents and includes all labor necessary and all materials and equipment incorporated or to be incorporated.

(30). *Work Site*. The location at which the Work will be delivered.

(b). *Miscellaneous*

(1). *Incorporation of Documents*. Notice to Proceed, and the Technical Specification Sections of Divisions 2 through 49, are incorporated herein.

(2). *Contradiction with Terms and Conditions.* In the event any Contract Document contradicts these terms and conditions, these terms and conditions will control.

(3). *Headings for Convenience.* Headings to divisions and paragraphs in the Contract Documents are used solely for convenience and will not be deemed to define or limit the provisions of the Contract Documents. No responsibility is assumed by NMSU or Project Architect for the omission or duplication made by Contractor or Subcontractors

(4). *Drawings and Specifications Complementary and Binding.* The Drawings and Specifications complement each other; what is called for by one is as binding as if called for by both. Where conflicting, Specifications take precedence over Drawings and large scale Drawings and Details take precedence over small scale Drawings.

(5). *Errors, Omissions, or Inconsistencies.* If any error, omission or inconsistency in the Drawings or Specifications is discovered, it must be brought to the attention of the Project Architect immediately for interpretation. In general, in case of any discrepancy, the better quality and larger quantity will be required.

3. Project Architect Responsibilities. The project management will be the responsibility of the Project Architect or the RCM if no project architect is designated.

(a). *Project Architect Responsible for Contract Administration*. The Project Architect will administer the Contract as described below.

(b). *Limitations on Project Architect's Responsibilities*. The Project Architect will not be responsible for and will not have control or charge of construction means, methods, techniques, sequences or procedures, or for safety precautions and programs in connection with the Work.

(c). *Access to the Work by the Project Architect*. The Project Architect must at all times have access to the Work and Work Site.

(d). *Certificates for Payment*. Based on the Project Architect's observations and an evaluation of Contractor's applications for payment, the Project Architect will make recommendations to the RCM for determination of the amounts owing to Contractor. The RCM will make final determinations of the amount owing and will submit signed Certificates for Payment in the determined amount owing.

(e). *Authority of the Project Architect.* The Project Architect has the following authority, without limitation:

(1). To interpret the construction requirements;

(2). To reject work which does not conform to the Contract Documents;

(3). To require inspections and tests of the Work; and

(4). To review and approve or take other appropriate action upon Contractor's submittals, such as shop drawings, product data and samples. The Project Architect's approval only indicates conformance with the design concept of the Work and with the information given in the Contract Documents. The Project Architect's approval of a specific item does not indicate approval of an assembly of which the item is a component.

(f). *Change Orders.* The Project Architect or RCM will prepare Change Orders in accordance with NMSU policy, and as provided in Section 13 of these Terms and Conditions.

(g). *Completion of the Work.* The Project Architect will:

(1). Conduct inspections to determine the Substantial Completion Date and the date of final completion;

(2). Receive and forward to the University Architect or RCM, for review, all written warranties and related documents required by the Contract Documents and assembled by Contractor; and

(3). Advise the RCM regarding the issuance of a final Certificate for Payment upon compliance with the requirements as specified in Section 10(e) of these Terms and Conditions.

4. NMSU Rights and Responsibilities.

(a). *Information and Services Required of NMSU.* Information or services under NMSU's control will be furnished by NMSU with reasonable promptness to avoid delay in the orderly progress of the Work. Unless otherwise provided in the Contract Documents, Contractor will be furnished, free of charge, digital copies of Drawings and Specifications reasonably necessary for the execution of the Work. Normally, NMSU will forward instructions to Contractor through the Project Architect.

(b). *NMSU's Right to Stop the Work.* NMSU may, at its sole discretion, by written order direct Contractor to stop the Work, or any portion thereof, if Contractor (1) fails to correct defective Work or, (2) fails to carry out the Work

in accordance with the Contract Documents. NMSU is not responsible for stopping the Work under any circumstances.

(c). *NMSU's Right to Carry Out the Work*. Within seven (7) days of written notice from NMSU, Contractor must commence correction of any failure to carry out the Work in accordance with the Contract Documents. Contractor will be responsible for the cost of correcting the deficiencies, including but not limited to additional project management cost and the Project Architect's additional services made necessary by the deficiencies.

5. Contractor Responsibilities.

(a). *Contractor's Familiarity with Work Site.* Contractor represents he is familiar with the Work Site and local conditions under which the Work is to be performed. Contractor also agrees that the Work Site and local conditions are consistent with the representations in the Contract Documents.

(b). *Review of Contract Documents*. Contractor must carefully study and compare the Contract Documents and must immediately report to the Project Architect any error, inconsistency or omission it may discover. Contractor will be liable to NMSU for any damage resulting from Contractor's failure to report any such errors, inconsistencies or omissions in the Contract Documents.

(c). *Supervision and Construction Procedures*. Contractor will be solely responsible for all construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the Work. Contractor will be responsible to NMSU for the acts and omissions of its employees, Subcontractors and their agents and employees, and other persons performing any of the Work under a contract with Contractor or with a Subcontractor or supplier. Contractor must have a superintendent on site at all times when the Work is being performed. Contractor will at all times enforce strict discipline and good order. Contractor is ultimately responsible for the performance of the Work.

(d). *Labor and Materials*. Contractor must provide and pay for all labor, materials, equipment, construction equipment and machinery, and tools necessary for proper execution and completion of the Work.

(e). *Workmanship and Materials Standards*. Workmanship must conform to industry standards and must be executed by experienced, skilled and competent craftsmen. Materials must be best grade, new or as specified.

(1). *Standards.* Materials and equipment specified by manufacturer, name or number, will be considered as establishing standards for the Work. No substitute materials or equipment will be used except with prior written approval from the Project Architect. Proposed substitute materials and equipment must be equal in size, grade and quality. The

Project Architect, in his sole discretion, will determine suitability of materials and equipment for use in the Work.

(2). *Requests for Substitutions of Materials.* All requests for approval of substitutions of material, or equipment must be made no later than 45 days after the Notice to Proceed.

(3). *Prompt Submission of Drawings, Product Data, and Samples.* Contractor must submit all shop drawings, product data and samples required by the Contract Documents to the Project Architect for approval with reasonable promptness and in such sequence as to not cause a delay in the Project.

(4). *Contractor Warrants Supplier and Subcontractor Drawings, Product Data, and Samples.* By submitting suppliers' and Subcontractors' shop drawings, product data, and samples to the Project Architect; Contractor warrants that the submittals comply with the requirements of the Contract Documents.

(5). *Contractor Responsibilities for Obtaining Project Architect Approval.* The Project Architects' approval of shop drawings, product data or samples will not relieve Contractor of responsibility for any deviation from or revisions to the requirements of the Contract Documents, unless Contractor has specifically informed the Project Architect, in writing, of the deviation or revision at the time of submission and obtained the Project Architect's written approval of the deviation. This section does not apply to revisions requested by the Project Architect.

(6). *Project Architect Approval Prior to Commencing Work.* No portion of the Work requiring submission of a shop drawing, product data or sample will be commenced until the submittal has been approved by the Project Architect.

(f). *Warrantees and Guarantees*.

(1). *Workmanship Warranty and Materials Guarantee.* The Work will be warranted and guaranteed against faulty materials and workmanship for a period of not less than one year from date of Substantial Completion of the Work. Contractor will require all of its suppliers and Subcontractors to provide to NMSU at least a one-year workmanship warranty and materials guarantee. All other warranty and guarantees required by the Contract Documents are in addition to the workmanship warranty and materials guarantee. No other Contract Document can reduce or eliminate the warranty and guarantee requirements contained in this section.

(2). *Equipment.* Equipment incorporated into the Work must bear the manufacturer's standard warranty. Upon acceptance of the Work, all brochures, manuals, and operating procedures of equipment incorporated into the Work will be provided to NMSU.

(3). *Roofing.* Unless specified for a longer time period, roofing must have a no-dollar limit manufacturer's warranty for at least ten (10) years. Contractor or its roofing Subcontractor must be approved by the manufacturer to install the roofing system.

(4). *Carpet.* Unless specified for a longer time period, carpet must have at least a ten (10) year manufacturer's warranty.

(g). *Manufacturer's Directions*. All manufactured articles, materials and equipment must be applied, installed, connected, erected, used, cleaned and conditioned as directed by manufacturer unless otherwise specified, or directed by the Project Architect.

(h). *Defective Performance*. All Work not conforming to the Contract Documents, including substitutions not properly approved and authorized, may be considered defective.

(i). *Permits, Fees and Notices*.

(1). *Contractor Responsibility for Permits and Fees.* Unless otherwise provided in the Contract Documents, Contractor will secure and pay for all permits and governmental fees, licenses and inspections necessary for the proper execution and completion of the Work.

(2). *Contractor Compliance.* Contractor must give all required notices and otherwise comply with all laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the Work.

(3). *Contractor Responsibility for Contract's Compliance.* It is the responsibility of Contractor to make certain that the Contract Documents are in accordance with applicable laws, statutes, building codes and regulations. If Contractor believes the proposed Work would be in violation of any applicable laws, statutes, building codes and regulations, Contractor must promptly notify the Project Architect in writing, and any necessary changes must be accomplished by appropriate modification. If the Project Architect determines that the proposed Work would not violate any applicable laws, statutes, building codes or regulations, Contractor must continue performance of the Work in accordance with the Contract Documents.

(4). *Contractor Responsibility for Work Not in Compliance.* If Contractor performs any work that violates any applicable laws,

ordinances, rules and regulations, Contractor will assume full responsibility therefore and will bear all costs attributable thereto.

(5). *Testing and Sampling Fees. The Fees for* testing and sampling of concrete, soil and Special Testing required by IBC, Chapter 17, are the responsibility of NMSU.

(j). *Wage Rates.*

(1). *Public Works Minimum Wage Act.* For any project exceeding $60,000 in total costs before taxes, including all Change Orders, the New Mexico Public Works Minimum Wage Act, §13-4-10 through §13-4-17 NMSA 1978, requires all contractors and subcontractors to pay wages in compliance with the Act and to be registered with the Labor and Industrial Division of the New Mexico Department of Labor.

(2). *Davis-Bacon and Related Acts.* For any project that is paid for with federal funds in excess of $2,000 the Davis-Bacon Act, 40 U.S.C. 3141 *et seq*., requires that contractors and subcontractors pay laborers and mechanics employed on the project no less than the locally prevailing wage and fringe benefits for corresponding work on similar projects in the area, as determined from time to time by the U.S. Department of Labor. Related acts apply these provisions to federally funded or federally assisted construction. These "related acts" include, but are not limited to, the Federal-Aid Highway Acts, the Housing and Community Development Act of 1974, and the Federal Water Pollution Control Act.

(3). *United States Executive Order 13658, Minimum Wage*. This paragraph j(3) applies if the Project is funded with federal funds. Executive Order 13658, Minimum Wage, established a minimum wage for Contractors and Subcontractors. The amount of the minimum hourly wage changes annually. The current amount and any exclusions from the applicability of this requirement are available from the U.S. Department of Labor Wage and Hour Division.

(k). *Superintendent*. Contractor must employ a competent superintendent and necessary assistants who will be in attendance at the Project site during the progress of the Work. The superintendent will represent Contractor and all communications given to the superintendent will be as binding as if given to Contractor. Contractor must maintain a written log of all substantive communication regarding the Work.

(l). *Schedule of Values.* Contractor, within ten (10) days of the date of Notice to Proceed, must submit to the Project Architect a schedule of values. The schedule details the amount allocated to each portion of the Work. The Project Architect may specify the format of the schedule and nature of the data used to substantiate its accuracy. An updated schedule must accompany Contractor's

applications for payment, with columns showing the following for each portion of the Work: 1) scheduled value, 2) amounts included from prior applications for payment, 3) work in place, 4) stored materials, 5) total stored and completed to date, 6) percentage completed, and 7) balance to finish. The Schedule of Values must also include a line item for Contract closeout requirements.

(m). *Contract Closeout Requirements*. Unless otherwise agreed between the RCM and Contractor, the Contract closeout requirement line item will be three (3%) percent of the total Contract Sum, excluding taxes. Additionally, NMSU will have the right to add additional items to the schedule of values.

(n). *Documents and Samples at the Work Site*. Contractor must maintain at the Work Site one (1) record copy of all drawings, specifications, addenda, approved shop drawings, product data, samples, Change Orders, and other modifications in good order and kept current to record all changes made during construction. These records must be available to NMSU during the term of the Work. A legible copy of "as-built" drawings or record documents must be delivered to the Project Architect upon Substantial Completion.

(o). *Use of Work Site*. Contractor must confine operations at the Work Site to areas permitted by law, ordinances, permits and the Contract Documents. The Work Site must be maintained in a manner as to facilitate orderly completion of the Work.

(p). *Work Site Responsibilities of Contractor*. Contractor will hold NMSU harmless from damage from trespassing on property of others.

(q). *Damage to NMSU's Work or Property.* Should Contractor cause damage to the Project, any property of NMSU or anyone else's property, Contractor must promptly remedy such damage at its own expense.

(r). *Cutting and Patching of Work*. Unless otherwise specified, Contractor will be responsible for all cutting, fitting or patching that may be required to complete the Work or to make its several parts fit together properly. Contractor must receive written approval from Project Architect prior to cutting or patching any NMSU property.

(s). *Cleanup*. Contractor at all times must keep the Work Site free from accumulation of waste materials or rubbish. Upon completion of the Work Contractor must remove the waste materials, rubbish, tools, construction equipment, machinery and surplus materials from the Work Site. Any waste materials and rubbish defined as hazardous or with specific disposal requirements must be disposed of in accordance with the applicable laws, ordinances or regulations. If Contractor fails to clean up at completion of the Work, NMSU may do so and Contractor will be responsible for the cost of cleanup. Contractor, at its expense, must properly dispose of all clean, uncontaminated soils excavated and not reused for the Work.

(t). *Utility Location and Shutoff*.

(1). *Utility Location.* Contractor must comply with the requirements of §62-14-1 *et. seq.* NMSA 1978; regarding the location, excavation and protection of utilities. Responsibilities for the location of existing utilities, their protection, and repair of damaged utilities will be assigned in accordance with §62-14-1 *et. seq*. NMSA 1978. The New Mexico One Call number to request location of utilities is 1-800-321-2357 or 811.

(2). *Scheduling Disruptive Activities.* Contractor must submit to the Project Architect a written request to schedule construction activities which require interruption of any power, water, sewer, natural gas, steam, chilled water, vacuum, compressed air, HVAC, security systems, fire alarms or suppression, or which will impede pedestrian traffic, emergency egress, or vehicle access of any kind (collectively Disruptive Activities). Unless a longer time period for notification of request is required by the Contract Documents, Contractor must submit its written request not less than twenty-one (21) days before any Disruptive Activities. Contractor's request for approval of Disruptive Activities must state the nature of the task, the anticipated duration of the activity, and the impact the Disruptive Activities will have on adjacent facilities and users. Written approval of the Project Architect must be received prior to commencement of any Disruptive Activities.

(3). *Utility Shutoff and Resumption by NMSU Personnel.* Unless otherwise instructed in writing by the Project Architect, the actual closing and opening of valves and switches for shutoff and reconnection of utilities and services must be performed by NMSU Facilities and Services personnel. Contractor will be solely responsible for all damages associated with unauthorized opening and closing of valves and switches.

(u). *Communications*. Contractor must forward all communications to NMSU through the Project Architect. Contractor may respond directly to requests from Procurement Services, the University Architect and the RCM.

(v). *Royalties and Infringements*. Contractor will pay all royalties and license fees. Contractor will indemnify and hold harmless NMSU and its agents and employees from and against all claims, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or resulting from violation of any intellectual property right.

(w). *Indemnification*. Contractor will indemnify and hold harmless NMSU and its agents and employees from and against all claims, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or resulting from the performance of the Work. Such obligation will not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity,

which would otherwise exist as to any party or person, described in the Contract Documents. Any and all liability of NMSU arising from the Contract Documents, the Work, or the Project, including any obligation to indemnify Contractor, is subject to the immunities and limitation of the Tort Claims Act, §41-40-1 *et. seq*. NMSA 1978, and any amendments thereto.

6. Subcontractor Responsibilities.

(a). *Requirement for Written Agreement*. All Subcontractors must enter into a written agreement with Contractor providing for the performance of the Work to be performed. That agreement must incorporate by reference the Contract Documents and must require the Subcontractor to comply with the Contract Documents. All Subcontractors must incorporate the Contract Documents and their agreement with Contractor into any further subcontract.

(b). *Subcontractors Fair Practices Act*. If Contractor wants to perform the Work instead of a listed Subcontractor, to add a Subcontractor, or to replace a listed Subcontractor, NMSU must give prior written consent to the substitution in accordance with the Subcontractors Fair Practices Act, §13-4-31 to §13-4-42 NMSA 1978. Requests for consent of NMSU to substitute Subcontractors, or to perform in-house work of a Subcontractor, or supplement a Subcontractor must be submitted to the NMSU Director of Procurement Services, New Mexico State University, Box 30001, MSC 3890, Las Cruces, New Mexico 88003-0001. All costs, including attorney's fees, incurred by NMSU because of Contractor's failure to comply with the Subcontractors Fair Practices Act will be paid by Contractor, and may be deducted from any amount due.

7. Work by NMSU or by Other Contractors.

(a). *NMSU Right To Perform Work And To Award Separate Contracts*. NMSU reserves the right to perform work related to the Project with its own forces, or to award separate contracts in connection with other portions of the Project or other work on the site under these or similar conditions of the Contract Documents. NMSU will provide for the coordination of the work of its own forces and of each other contractor. Contractor must cooperate with NMSU and with all other contractors with whom NMSU may have contracted.

(b). *Mutual Responsibility*.

(1). *Space for Work and for Materials*. Contractor will afford NMSU and other contractors reasonable space for the introduction and storage of their materials and equipment and the execution of the Project. Contractor will connect and coordinate its Work with all other work on the Project. NMSU will not be liable for off-site storage space.

(2). *Coordination of Work.* If any part of Contractor's Work depends upon proper execution or results of the work of NMSU or of any other

contractor, Contractor must, prior to proceeding with the Work, promptly report to the Project Architect or RCM any apparent discrepancies or defects in such other work that render it unsuitable. Failure of Contractor to report discrepancies or defects will constitute an acceptance of NMSU's or any other contractors' work as fit and proper to receive its work except as to defects which may subsequently become apparent in such work by others.

(3). *Improperly Scheduled Work*. Any cost caused by improperly scheduled work will be borne by the party that improperly scheduled the work.

(4). *Damage to NMSU's Work or Property*. Contractor is responsible for all damage to the Work, and property of NMSU caused by Contractor.

8. Miscellaneous Provisions.

(a). *Prompt Payment Act.* Contractor and its subcontractors must comply with all applicable provisions of the Prompt Payment Act, §57-28-1 to §57-28-11 NMSA 1978, including without limitation payment provisions therein and must ensure that their construction contracts comport with the provisions of the Act.

(b). *New Mexico Gross Receipts Taxes.* Contractor will be required to pay applicable New Mexico Gross Receipts Tax. NMSU will reimburse Contractor for New Mexico Gross Receipts Tax on amounts due Contractor pursuant to the Contract Documents. New Mexico Gross Receipts Tax must be shown as a separate amount on each billing or request for payment.

(c). *Equal Employment Opportunities*. Section A 7 regarding equal employment opportunities applies to Contractor and Subcontractors at any tier.

(d). *Prohibition of Assignment*. Contractor may not assign the Contract in whole or in part. Contractor may not assign any monies due or to become due to it under the Contract Documents.

(e). *Written Notice*. All notices to NMSU must be given to the RCM in writing and must be sent by certified mail, return receipt requested, postage prepaid, overnight currier, fax, or email.

(f). *Default by Contractor*. If Contractor defaults or breaches the terms of the Contract Documents, Contractor must commence and continue correction of such default or breach with diligence and promptness, but in no case later than seven (7) days after written notice from the RCM of the default or breach. Contractor must bear the cost, including architectural fees, of correcting any default or breach. If Contractor fails to remedy breach from the first seven days' notice from NMSU, NMSU will issue a second seven (7) day notice. If Contractor fails to remedy the default or breach following the second seven day notice the Contractor

may be removed from the Work and will be responsible for all cost incurred by NMSU to finish the Work.

(g). *Rights and Remedies*.

(1). *Rights and Remedies Not Limited by Contract Documents*. The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder will be in addition to and not a limitation of any duties, obligations, rights and remedies otherwise imposed or available by law.

(2). *No Waiver of Rights except by Specific Writing*. No action or failure to act by NMSU or Project Architect will constitute a waiver of any right or duty afforded them under the Contract Documents.

(3). *Attorney Fees in Event of Default or Violation by Contractor*. In the event that Contractor is in default of the Contract Documents, Contractor agrees to pay reasonable attorney's fees and expenses so incurred by NMSU.

(h). *Liquidated Damages as a Result of Delay by Contractor*. Parties to this Contract acknowledge that it is difficult to determine actual damages, should Contractor fail to perform by the date(s) specified in the Contract Documents. Parties further agree that the amount specified for liquidated damages is not unreasonable, nor punitive in nature.

(i). *Tests and Inspections*.

(1). *Cost of Tests and Inspections; Notice to Project Architect.* If the Contract Documents, the laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any portion of the Work to be inspected, tested or approved, Contractor must give the Project Architect timely notice of its readiness so the Project Architect may observe such inspection, testing or approval. Contractor will bear all costs of such inspections, tests, or approvals.

(2). *Right of Project Architect to Require Inspection or Testing*. If the Project Architect determines that any work requires special inspection, testing, or approval, he will, upon written authorization from NMSU, instruct Contractor to order such special inspection, testing or approval, and Contractor must give timely notice of the special inspection, testing or approval. If such special inspection or testing reveals a failure of the work to comply with the requirements of the Contract Documents, Contractor will bear all costs of special inspection, testing, or approval and all remedial measures, including Project Architect fees made necessary by such failure; otherwise NMSU will bear such costs of the

special inspection, testing, or approval, and an appropriate Change Order will be issued.

(3). *Certificates of Inspection or Testing.* Required certificates of inspection, testing or approval must be secured by Contractor and promptly delivered to the Project Architect.

(4). *Right of Project Architect to Observe.* The Project Architect may from time to time observe the inspections, tests or approvals required by the Contract Documents.

9. Commencement and Progress**.**

(a). *Time of the Essence*. All time limits stated in the Contract Documents are of the essence.

(b). *Date of Commencement*. Work must commence not later than ten (10) days after the date of the Notice to Proceed.

(c). *Delays and Extensions of Time*.

(1). *Delay Not Caused by Contractor.* If Contractor is delayed by any causes beyond Contractor's control, then the Contract Time may be extended by Change Order for such reasonable time as NMSU may determine. Time to obtain a permit is not considered beyond Contractors control.

(2). *Claim for Extension of Time.* The Contractor must submit a written claim requesting an extension of the Contract Time to the Project Architect within twenty (20) days of the commencement of the delay. The claim must include an estimate of the probable effect of the delay on the Work.

(3). *Recovery of Damages Caused by Delay Not Limited.* This Section does not preclude the recovery of damages for delay under any other provisions of the Contract Documents.

10. Payments and Completion.

(a). *Contract Sum*. The Contract Sum stated in the NMSU Purchase Order, including all Change Orders, is the maximum amount payable by NMSU for the performance of the Work.

(b). *Applications for Payment*.

(1). *Submission of Applications for Payment.* Contractor will submit to the Project Architect a notarized application for payment. Each application for payment must be supported by the current schedule of

values statement and such other data substantiating Contractor's right to payment as or the Project Architect may require.

(2). *Period of Work.* The period of work covered by each application for payment is the calendar month within which the application for payment is made. Application for payment should be received on or before the twenty-fifth (25th) day of the period of work, and the progress payment will be made within 21 days thereafter in accordance with the Prompt Payment Act, §57-28-1 to §57-28-11 NMSA 1978.

(3). *Payment for Materials or Equipment not yet Incorporated in the Work.* With advance written approval of the Project Architect, payment will be made for materials or equipment not yet incorporated in the Work but delivered and suitably stored at the Work Site or other approved location. Payments for materials or equipment stored on the Work Site will be conditioned upon submission by Contractor of manufacture or suppliers invoice or such other procedures satisfactory to NMSU to establish NMSU title and access to such materials or equipment or otherwise protect NMSU's interest. Payments for materials or equipment stored off-site will only be made to Contractor if a Financing Statement and Security Agreement approved by NMSU is properly signed and filed. NMSU may impose other conditions it determines appropriate prior to payment.

(4). *Warranty of Clear Title.* Contractor must warrant that title to all Work, materials and equipment covered by an application for payment will pass to NMSU, free and clear of all liens, claims, security interests or encumbrances, either by incorporation in the construction or upon the receipt of payment by Contractor, whichever occurs first.

(5). *Certificates for Payment.* The Project Architect will, after the receipt of Contractor's application for payment, make recommendations to the RCM for determination of the amounts due Contractor. NMSU will either issue a Certificate for Payment, with a copy to Contractor, for the amount the RCM determines is due, or notify Contractor in writing of the reasons for withholding a Certificate for Payment. NMSU's determination is final. By issuing a Certificate for Payment, NMSU does not represent that the Project Architect has: made exhaustive or continuous on-site inspections, reviewed the construction means, methods, techniques, sequences or procedures, or made any examination to ascertain how or for what purpose Contractor has used the monies previously paid.

(6). *Certificates Withheld.* The RCM may decline to certify payment or, because of subsequently discovered evidence or subsequent observations, with recommendations of the Project Architect he may nullify the whole or any part of any Certificate for Payment previously

issued, to the extent as may be necessary in his opinion to protect NMSU from loss because of: (1) defective work not remedied; (2) third-party claims filed or reasonable evidence indicating probable filing of such claims; (3) failure of Contractor to make payments properly to Subcontractors for labor, materials or equipment; (4) reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum; (5) damage to NMSU or another contractor; (6) reasonable evidence that the Work will not be completed within the Contract Time, (7) persistent failure to carry out the Work in accordance with the Contract Documents; or (8) any other condition or event which may cause loss to NMSU. NMSU may make partial payment to Contractor.

(7). *Timely Payment of Employees and Subcontractors*. Contractor must timely pay Subcontractors and laborers. Contractor must, by an appropriate agreement with each Subcontractor, require each Subcontractor to make payments to its laborers, subcontractors at any tier, and suppliers, in similar manner pursuant to Subcontractors Fair Practices Act.

(8). *Joint Checks*. NMSU, in its sole discretion, may issue joint checks to a governmental agency, the courts, Subcontractors, or suppliers.

(9). *NMSU Payment Responsibility Limited to Contractor*. NMSU will have no obligation to pay or to see to the payment of any monies to any individuals, laborers, Subcontractors, suppliers, or any entity entitled to payment, except Contractor.

(10). *Information to Subcontractors*. The Project Architect, RCM or both may, on request and at its discretion, furnish to any Subcontractor, if practicable, information regarding the percentages of completion or the amounts applied for by Contractor and the action taken thereon by the Project Architect on account of work done by such Subcontractor.

(11). *Progress Payment Not Acceptance of Work*. No certificate for a progress payment, nor any progress payment, nor any partial or entire use or occupancy of the Project by NMSU, will constitute an acceptance of any work not in accordance with Contract Documents.

(c). *Substantial Completion*.

(1). *Inspection by Project Architect Required*. When Contractor believes Substantially Complete has been achieved Contractor must call for an inspection by the Project Architect.

(2). *Certificate of Substantial Completion*. When the Project Architect determines that Substantial Completion has been achieved, the Project

Architect will prepare a Certificate of Substantial Completion and a punch list of items to be completed or corrected. The Certificate of Substantial Completion must be submitted to RCM and Contractor for their written acceptance of the responsibilities assigned to them. Substantial Completion is not effective until accepted in writing from the RCM.

(3). *Omissions by Project Architect.* The Project Architect's omission of any items on Substantial Completion punch list will not alter the responsibility of Contractor to complete all work in accordance with the Contract Documents.

(4). *Responsibilities at Substantial Completion.* At the sole discretion of NMSU the Project Architect may state in writing the responsibilities of NMSU and Contractor for security, maintenance, heat, utilities, damage to the Work, and insurance, and will fix the time within which Contractor must complete or correct the items listed on the punch list.

(5). *Effective Date of Warranties.* Warranties required by the Contract Documents will commence on the Date of Substantial Completion unless otherwise provided in the Certificate of Substantial Completion or contract change order.

(6). *Payment for Substantial Completion.* Upon Substantial Completion and upon application by Contractor and certification by the RCM, NMSU will make payment to Contractor.

(d). *Application For Final Payment.* Contractor must submit a final application for payment upon completion of the Project including all punch list items and delivery of all warranties and closeout documents to NMSU, including: (1) release of liens, (2) warranties, (3) operation and maintenance manuals, (4) release of surety, and (5) as-built or record documents to the Project Architect. The final application must be reviewed by the Project Architect and must contain a certification of accuracy of the final application. Contractor understands and agrees that NMSU from time to time may require Contractor to furnish additional closeout documents. NMSU will be entitled to hold the final payments until closeout document have been presented to NMSU.

(e). *Final Completion and Payment*.

(1). *Final Inspection by Project Architect Required.* Contractor must give written notice to the Project Architect when the Work is ready for final inspection. When the Project Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Project Architect will promptly advise the RCM to issue a final Certificate for Payment.

(2). *Contractor Requirements to Receive Final Payment*. The final payment will not become due until Contractor submits through the Project Architect: (A) an affidavit that all payrolls, bills for materials and equipment, and other indebtedness connected with the Work have been paid or otherwise satisfied, and (B) other data establishing payment or satisfaction of all other contract obligations, such as receipts, release and waivers of liens and release of surety arising out of the Contract, to the extent and in such form as may be designated by NMSU. NMSU at its discretion may require releases of lien or waiver from Subcontractors. If any Subcontractor refuses to furnish a release or waiver, Contractor may furnish a bond satisfactory to NMSU to indemnify it against any claims by the Subcontractor. If any Subcontractor claims remains unsatisfied after all payments are made by NMSU to the Contractor, Contractor must refund to NMSU all monies that NMSU may be compelled to pay in discharging the Subcontractor's claim including all costs and reasonable attorneys' fees.

(3). *Effect of Final Payment on Contractor Claims*. The acceptance of final payment will constitute a waiver of all claims by Contractor except those previously made in writing and identified by Contractor as unsettled at the time of the final application for Payment.

11. Protection of Persons and Property.

(a). *Safety Precautions and Safety Education Programs*. Contractor will be responsible for initiating, maintaining and supervising all safety precautions and safety education programs in connection with the Work.

(b). *Safety of Persons and Property*.

(1). *Safety Precautions*. Contractor must take all reasonable precautions for the safety of, and must provide all reasonable protection to prevent damage, injury or loss to: (A) all employees on the Work and all other persons who may be affected; (B) all work and all materials and equipment to be incorporated therein, whether in storage on or off the site, under the care, custody or control of Contractor or anyone directly contracting with, or indirectly employed by Contractor, and (C) other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

(2). *Safety Compliance and Notices*. Contractor must give all required notices and comply with all applicable laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the safety of persons or property or their protection from damage, injury or loss.

(3). *Safeguards and Signage*. Contractor must erect and maintain, as required by existing conditions and progress of the Work, all reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying NMSU and users of adjacent utilities.

(4). *Use of Specialized Equipment*. When the use of specialized lifting equipment (aerial lifts, cranes, scaffolds, platforms, etc.), is used for the execution of work and could potentially affect or create a hazard to NMSU property outside the construction zone, Contractor must first notify the NMSU Environmental Health and Safety Officer by contacting the RCM.

(5). *Use and Storage of Hazardous Materials*. When the use or storage of hazardous materials is necessary for the execution of the Work, Contractor must exercise the utmost care and must carry on such activities under the supervision of properly qualified personnel. When using or storing hazardous materials at jobsite, Contractor must first notify the NMSU Environmental Health and Safety Officer by contacting the RCM.

(6). *Site Safety Coordinator*. Contractor must designate a responsible member of its organization at the site whose duty will be the prevention of accidents.

(7). *Safety in Loading NMSU Property with Materials*. Contractor must not load or permit any part of the Work or other NMSU property to be loaded so as to endanger its safety. This includes, but is not limited to, the placement of roofing materials on roofs. All materials must be distributed in such a manner so as to prevent overloading of the designed capacity of the supporting element(s).

(c). *Safety and Environmental Requirements*.

(1). *Compliance with Safety Requirements*. Contractor will provide for the safety of workers, NMSU personnel, and the public. Contractor must comply with the requirements of regulating agencies for public health and safety, the Occupational Safety and Health Administration's (OSHA) rules and regulations, and with all applicable safety laws and regulations.

(2). *Temporary Enclosures or Barricades.* Contractor must provide and maintain temporary enclosures or barricades at excavations, at perimeter of all construction zones dedicated for the contractor's use, pathways, building and area entries, walkways subject to falling objects and hazardous material removal sites.

(3). *Environmental Requirements*. Contractor and Subcontractors at any tier must abide by all applicable regulations of: (A) the Department of Transportation; and (B) the Environmental Protection Agency when transporting hazardous material. In the event the Contract Documents require transportation of hazardous materials, prior to such transportation, Contractor must submit the following to the RCM for approval by the NMSU Environmental Health and Safety Officer:

(A). Proof of a Department of Transportation (DOT) Registration Number.

(B). Proof of a DOT Hazardous Material Transportation Security Plan, if applicable.

(C). Proof of Contractor's personnel receiving DOT Hazardous Material Transportation Training, and, if applicable, DOT Specific Security Plan Training and;

(D). Proof of an Environmental Protection Agency (EPA) Identification Number.

(4). *Encountering Certain Hazardous Materials on Site*. If Contractor encounters at the Work Site material reasonably believed to contain asbestos containing material (ACM), presumed asbestos containing material (PACM), lead paint, or polychlorinated biphenyl (PCB) which has not been rendered harmless and is not scheduled during the performance of the Work to be rendered harmless and the hazardous material must be disturbed for performance of the Work, Contractor must immediately stop work in the area affected and report the condition to the Project Architect in writing. Work in the affected area will not resume until the material is rendered harmless, and it is agreed in writing by the RCM and Contractor that Work in the affected area can safely resume.

(5). *Prohibition on Introducing Certain Hazardous Materials to the Work Site*. Contractor must not bring to the Work Site, nor allow to be incorporated into the Work any material containing ACM, lead paint, or PCB. Any materials incorporated into the Work, and later found to contain ACM, lead paint, or PCB will be removed at the expense of Contractor, including all containment, air clearances and disposal, without any additional or incidental costs to NMSU.

(6). *Precluding or Minimizing Lead and Mercury in Equipment and Fixtures*. Light fixtures, mechanical and electrical equipment supplied or installed must not contain lead or mercury. For example, non-mercury thermostats should be installed. Light bulbs certified as "low mercury"

i.e. with industry standard green tips/green labeling, may be used with RCM approval.

(7). *Lead-free Plumbing.* Fixtures, piping, solder and flux provided under this Contract and used in the installation of systems delivering water for human consumption must be lead-free. The term lead-free is defined as pipe and fixtures which do not contain more than 8.0% lead and solder, and flux which does not contain more than 0.2% lead.

(8). *Storm Water Control at Site*. The Clean Water Act, 33 U.S.C 1342 *et. seq*., prohibits the discharge of any pollutants to navigable waters from a point source unless discharge is authorized by a National Pollutant Discharge Elimination System (NPDES) permit. Phase II of the NPDES storm water program covers small construction activities disturbing 1 to 5 acres. Contractor(s) must comply with all regulations and requirements of Phase II including as follows: (A) submission of a Notice of Intent; (B) development implementation and inspection of a Storm Water pollution prevention plan; (C) applying and receiving a permit; and (D) submission of Notice of Termination.

(d). *Emergencies*. In any emergency affecting the safety of persons or property, Contractor must act to prevent threatened damage, injury or loss. Any additional compensation or extension of time claimed by Contractor on account of emergency work will be determined as provided elsewhere for changes in the Work.

12. Bonding and Insurance.

(a). *Requirements for Bonding*. When Contractor is awarded a Contract in excess of Twenty-Five Thousand Dollars ($25,000), the following surety bonds must be delivered to NMSU, in force for the Contract Time and in the amount of the Contract Sum including any applicable taxes. The bonds will become binding on the parties upon the execution of the Contract.

(1). *Performance Bond.* A bond as security for the faithful performance of the Contract (Performance Bond) satisfactory to NMSU, in an amount equal to the Contract Sum; and

(2). *Material and Payment Bond*. A Material and Payment Bond satisfactory to NMSU, in an amount equal to the Contract Sum, for the protection of all persons supplying labor and material for performance of the Work for Contractor or its Subcontractors at any tier.

(3). *Requirements of Surety Company*. Bonds must be issued to NMSU and be executed by a surety company authorized to do business in the State of New Mexico in accordance with the New Mexico Insurance

Code, Chapter 59A NMSA 1978, and listed in U.S. Treasury Circular 570.

(b). *Power of Attorney*. An attorney-in-fact, who signs the Contract, or Performance or Payment bonds, must deliver to NMSU a notarized copy of the power of attorney.

(c). *Contractor's Insurance*. Contractor must have in force during Contract Time insurance as required by the Contract Documents.

(d). *Contractor's Liability Insurance.*

(1). *Required Insurance.* Contractor must purchase and maintain statutory limits of worker's compensation, public liability and automobile liability insurance approved by NMSU at the time of signing of the Contract Documents. All certificates of insurance must be executed by an insurance company authorized to do business in the State of New Mexico. NMSU must be included as an additional insured. Contractor must furnish NMSU with certificates of insurance with the Contract Documents prior to the commencement of the Work. NMSU requires at least ten (10) days' notice of cancellation.

(2). *Minimum Coverage Limits*. Public Liability and Automobile Liability insurance must include at least the following coverages:

(A). Bodily injury, each occurrence, excluding medical and medically-related expenses: $750,000.

(B). Medical and medically-related expenses: $300,000.

(C). Property Damage, each occurrence: $200,000.

(3). *Builder's Risk Coverage.* Builder's Risk insurance is the responsibility of Contractor through the date of final payment.

13. Changes in the Work.

(a). *Change Orders*. NMSU, without invalidating the Contract Documents, may order changes in the Work within the general scope of the Contract Documents consisting of additions, deletions or other revisions, adjusting the Contract Sum and the Contract Time accordingly. All changes in the Work must be authorized by written Change Order. By signing a Change Order, Contractor indicates its agreement with the Change Order, including any adjustment in the Contract Sum or the Contract Time. Contractor understands that NMSU will not order changes in the Work which include an adjustment in the Contract Sum or

an extension of the Contract Time inconsistent with the intent of the Contract Documents.

(b). *Claims for Adjustment to Contract Sum*.

(1). *Notice to the Project Architect*. If Contractor believes it has a claim for an increase in the Contract Sum including weather delays, he must give the Project Architect written notice of the change within fourteen (14) days after the occurrence of the event giving rise to such claim. This notice must be given by Contractor before proceeding to execute the work giving rise to the claim giving increase to the Contract Sum, except in an emergency endangering life or property. In an emergency, Contractor must proceed in accordance with other applicable provisions of this Document.

(2). *Method to Determine Amount of Change*. The cost or credit to NMSU resulting from a change in the Work will be determined by mutual agreement between NMSU and Contractor. Such adjustments will be determined by one of the following methods at the sole discretion of NMSU:

(A). Prices based on percentages or fractions of prices used in the Original Proposal by which the Project was awarded to Contractor, for deletion of, or the addition of work;

(B). A lump sum amount, agreed to by the contracting parties; or

(C). Contractor's estimate for cost of labor, material, rentals, and equipment plus overhead and profit combined and added as one percentage sum only (not compounded). The Project Architect has the right to require Contractor to provide breakdowns of estimated costs of labor and materials.

(3). *Overhead and Profit*. Allowances for overhead and profit may be made only on Change Orders resulting in net increases to the Contract Sum, based on the following schedule:

Change Order Amount Before Markup	Contractor/ Subcontractor O/H & Profit for Work by Own Forces	Contractor O/H & Profit for Work by Subcontractors
Less than $20,000	12%	8%
$20,001 or greater	7%	5%

(A). Overhead is defined as General Overhead Cost (Indirect Expenses) to include: Contractor or Subcontractor's office expenses (office rent or lease expense, office supplies, utilities, insurance, communication, office equipment, furniture, and taxes); Contractor's staff salary expenses (executives, administrative staff, purchasing staff, bookkeepers, office located project managers, scheduler, estimators, and miscellaneous office staff not directly employed on the project); and miscellaneous expenses (legal fees, license or association fees, consultant such as accountant, auditors, and information technology, depreciation expense, travel expense, and donations).

(B). Acceptable Temporary Facilities (Direct Expenses) applied to Change Orders may include the following costs as they apply to a specific Change Order request, and calculated on a prorated basis: site-located owned or leased office space, site-located storage buildings, sanitary facilities, drinking water and cups, travel or per diem expenses. Proration calculation: (original item cost) / (# of original days estimated) = (daily item cost). (accepted # of calendar day extension) X (daily item cost) = (Change Order item amount).

(C). Acceptable Labor (Direct Expenses) applied to Change Orders may include established hourly wage rate cost, plus actual burden, multiplied by the amount of time the individual is expected to work on the Change Order request. Onsite expenses may be applied to the onsite personnel including jobsite superintendent, foreman, field engineer, or other site personnel.

(4). *Equitable Adjustment of Unit Prices.* If unit prices are stated in the Contract Documents or subsequently agreed upon, and if the quantities originally contemplated are so changed in a proposed Change Order that application of the agreed unit prices to the quantities of work proposed will cause substantial inequity to NMSU or Contractor, the applicable unit prices will be equitably adjusted.

(c). *Concealed Conditions*. By agreement of the parties, the Contract Sum may be equitably adjusted by Change Order upon claim by either party made within fourteen (14) days after the first observance of the following: (1) concealed conditions encountered in the performance of the Work below the surface of the ground at variance with the conditions indicated by the Contract Documents; or (2)concealed unknown conditions of an unusual nature, differing from those ordinarily encountered and generally recognized as typical in work of the character indicated by the Contract Documents.

14. Uncovering and Correction of Work.

(a). *Uncovering of Work*.

(1). *Required in Contract Documents*. If any portion of the Work is covered contrary to requirements specifically expressed in the Contract Documents, it must, if required in writing by the Project Architect, be uncovered for observation by the Project Architect, and will be replaced at Contractor's expense.

(2). *Not Required in Contract Documents*. If any other portion of the Work has been covered which the Project Architect has not specifically requested to observe prior to being covered, the Project Architect with prior approval of NMSU, may request to see such work and it must be uncovered by Contractor. If such work is found to be in accordance with the Contract Documents, the cost of uncovering and replacement will, by appropriate Change Order, be charged to NMSU. If such work is not in accordance with the Contract Documents, Contractor must pay all costs of uncovering the work and the costs of bringing the Work into compliance with the Contract Documents.

(b). *Correction of Work*.

(1). *Contractor's Responsibility*. Contractor must promptly correct all work rejected by the Project Architect or RCM as defective or failing to conform to the Contract Documents whether observed before or after Substantial Completion and whether or not fabricated, installed or completed. Contractor will bear all costs of correcting the rejected work, including compensation for the Project Architect's additional services made necessary thereby.

(2). *Guarantee or Warranty Periods*. If, during the guarantee period, or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be defective or not in accordance with the Contract Documents, Contractor must correct it promptly. This obligation will survive termination of the Contract.

(3). *Removal by Contractor*. Contractor, at its own expense, must remove from the site all portions of the Work which are defective or non-conforming.

(c). *Acceptance of Defective or Non-Conforming Work*. If NMSU prefers to accept defective or non-conforming work, it may do so instead of requiring the work's removal and correction, in which case a Change Order will be issued to reflect a reduction in the Contract Sum where appropriate and equitable. If final payment has been made, Contractor must reimburse NMSU for its damages.

15. Termination of the Contract.

(a). *Termination by Contractor*. If a permit is not issued for the commencement of any portion of the Work, or if the Work is stopped for a period of thirty (30) days under an order of any court or other public authority having jurisdiction, or as a result of an act of government, such as a declaration of a national emergency making materials unavailable, through no act or fault of Contractor or anyone directly contracting with, or indirectly employed by it, or by anyone for whose acts Contractor is responsible for, then Contractor may, upon seven (7) additional days' written notice to NMSU to the Project Architect, terminate the Contract and recover from NMSU payment for reasonable, actual expenses to that date.

(b). *Termination by NMSU*.

(1). *Best Interests of NMSU*. If NMSU, in its best interests, requires termination of this Contract, the Contract may be terminated after giving Contractor and its surety, if any, seven (7) days' written notice. NMSU may require Contractor's surety to complete the Work. NMSU may also take possession of the site and of all materials, equipment, tools, construction equipment and machinery thereon owned by Contractor and may finish the Work by whatever method they may deem expedient. In either case, Contractor will not be entitled to receive any further payment until completion of the Work.

(2). *Payments after Termination by NMSU*. After performance of the Work and reimbursement of all costs of completion have been made, including payment to all persons directly contracting with, or indirectly employed by Contractor for performance of the Work who were not paid by Contractor for work performed, the unpaid balance of the Contract Sum, if any, must be paid first to the surety if surety completes the Work, and if any balance remains it will be paid to Contractor.

(3). *Costs of Completion Exceeding Unpaid Balance*. If costs of completion of the Work exceed the unpaid balance of the Contract Sum, Contractor must pay the difference to NMSU. The amount to be paid to contractor, the surety, or to NMSU, as the case may be, must be as recommended by the Project Architect and certified by the RCM upon application, in the manner provided elsewhere in these Terms and Conditions. This obligation for payment survives the termination of the Contract.

16. Brand Name and Equipment Specified.

(a). *Proprietary Items*. It has been determined that some of the equipment or materials identified in the Proposal Documents for this project are required to interface with the existing equipment or materials, and are considered proprietary.

Therefore, substitutions of those items of equipment or materials will not be accepted. Proprietary items are:

(1). Builders Hardware

(A). Cylindrical Locks: Yale Lever, 5400 Series, Augusta Trim

(B). Locks specific to Housing/Dormitory projects only: Marks Survivor 195 series cylindrical locks and Marks 55CL92F series mortise locksets.

(C). Keyways: Yale Restricted for all new Las Cruces campus projects. Contractor to furnish a new cylinder for each opening. Owner shall furnish key cores and install the final keyed cylinders.

(D). Keyways: Yale Restricted for all new DACC Community College and NMSU Satellite Campus projects. Contractor to furnish and install new cylinders and cores keyed to facility requirements.

(E). Finishes: All Hardware Finish, US26D

(F). Deadbolts: Lori, Single or Double Cylinder to accept the Yale Mortise Cylinder

(G). Deadbolts: Locks specific to Housing/Dormitory projects only: Schlage Deadbolts capable of accepting a Yale Restricted keyway

(H). Door Closers and Associated Components: LCN 4040 Series

(I). Exit Devices: Rim or Mortise Type only; Von Duprin 99 Series, no vertical rods installations allowed.

(2). Power Door Operators: Horton Series 7100 normal duty/4100 Heavy duty with the CL200 Card

(3). Door Card Readers: Blackboard – SA3000 Door Access System. NMSU will provide the Power Supplies, Master Controllers, SM88's, Door Controllers and Card Swipes for the project as these are proprietary to NMSU

(4). Facilities Management Systems: The subcontractors providing building automation services must be listed under the Owner's BACnet Prequalification program, which includes specifications of acceptable building automation devices. The firms listed under the program are:

(A). Automated Control Systems (Alerton), Albuquerque, NM

(B). Control and Equipment Co (Schneider Invensys), El Paso, TX

(C). PC Automated Control (Automated Logic), El Paso, TX

(D). Trane (Trane) – El Paso, TX

(E). Energy Control Inc. (Delta) – Las Cruces, NM

(F). GEW Mechanical (Reliable) - Albuquerque, NM

(G). NSW Controls (Reliable) – Albuquerque, NM

(H). Johnson Controls (Johnson Controls) – Albuquerque, NM

(I). ThermAir (Distech) Mesa, AZ

(5). Medium Voltage Distribution Equipment: by S&C or G&W with Elastomer

(6). Contractor-supplied Fire Alarm Control Panel:

(A). Firelite 9200UD with ECC-50/100 Voice Evac Panel

(B). Notifier NFS 2-640 with Firelite ECC-50/100 Voice Evac Panel

(C). Gamewell E3

(7). Utility Metering Systems:

(A). Meters for all Las Cruces campus projects are owner furnished and contractor installed equipment.

(B). Meters for all DACC Community College and NMSU Satellite Campuses are contractor furnished and installed equipment.

(C). Contact the Project Representative for requirement and location of individual meters in all locations.

The following meter brands are provided for basis of design and construction information only. See each manufacturer's product guidelines and/or specifications for general rough-in and installation requirements.

(D). Electrical Meters, as manufactured by Eaton metering system.

(E). Chilled Water Meters, as manufactured by Onicon.

(F). Condensate meter, as manufactured by Cadillac.

(8). Light Poles:

(A). Street, Parking lot and specialty light poles, as manufactured by Ameron Pole Products, Centrecon Series

(B). M – Series Round Pole – Embedded: MER08.5

(C). M – Series Round Pole – Base Mounting: MBR7.5

(D). M – Series Specifications: Mix (7R31): Valley Red, exposed aggregate finish with Amershield anti-graffiti coating

(E). Street, Parking lot and specialty light pole arms, as manufactured by American LitePole, Design number: UP6S or UP6D

(9). Stripping Solvent for ACM Mastic: AMW-98 by American Coating Corporation

003126 - EXISTING HAZARDOUS MATERIAL INFORMATION

A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.

B. An existing asbestos report for Project, prepared by ANE Consulting Inc, dated March 11, 2020, is available for viewing as appended to this Document.

C. Related Requirements:
   1. Document 003119 "Existing Condition Information" for information about existing conditions that is made available to bidders.
   2. Document 003132 "Geotechnical Data" for reports and soil-boring data from geotechnical investigations that are made available to bidders.
   3. Section 024116 "Structure Demolition"" for notification requirements if materials suspected of containing hazardous materials are encountered.

END OF DOCUMENT 003126

003132 - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.

B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, the Owner, the Architect, the Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report shall accept full responsibility for its use.

C. Soil-boring data for Project, obtained by Souder, Miller & Associates dated September 17, 2020 is available for viewing **as appended to this Document**.

D. A geotechnical investigation report for Project, prepared by Souder, Miller & Associates dated September 17, 2020 is available for viewing **as appended to this Document**.

1. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
2. Any party using information described in the geotechnical report shall make additional test borings and conduct other exploratory operations that may be required to determine the character of subsurface materials that may be encountered.

E. Related Requirements:
1. Document 003126 "Existing Hazardous Material Information" for hazardous materials reports that are made available to bidders.

Geotechnical Investigation Prepared by Souder, Miller & Associates date September 17, 2020 attached

END OF DOCUMENT 003132

NEW MEXICO STATE UNIVERSITY
BIOMEDICAL RESEARCH BUILDING EXPANSION

Geotechnical Investigation

Las Cruces, New Mexico
May 22, 2023

SMA

Souder, Miller & Associates
Engineering ♦ Environmental ♦ Geomatics

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May 22, 2023 #9332238

Ms. Ashley Burkholder, AIA
Project Manager
Facilities and Services: Project Development & Engineering
New Mexico State University
P.O. Box 30001
Las Cruces, New Mexico 88003
(575) 646-1927
Jasper7@nmsu.edu

RE: NMSU Biomedical Research Building Expansion
Geotechnical Investigation Report

Dear Ms. Burkholder,

Souder, Miller and Associates is pleased to present the enclosed Geotechnical Investigation Report for the above-referenced project. The report analyzes the existing subgrade soils within the proposed project site located at 3080 S. Espina Street on the New Mexico State University campus in Las Cruces, New Mexico and provides recommendations for earthwork and foundation design for the proposed building expansion and associated aviary.

Should you have any questions, require any further information, or if any portion of the report requires modification to meet your specific needs, please do not hesitate to contact our office.

Sincerely,

MILLER ENGINEERS, INC. D/B/A
SOUDER, MILLER & ASSOCIATES

Jenn Howell, P.E.
Project Engineer
jennifer.howell@soudermiller.com

Paul J. Pompeo, P.E.
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Enc: NMSU Biomedical Research Building Expansion Geotechnical Investigation Report

GEOTECHNICAL INVESTIGATION

NEW MEXICO STATE UNIVERSITY
BIOMEDICAL RESEARCH BUILDING EXPANSION
LAS CRUCES, NEW MEXICO

Prepared for

New Mexico State University
Facilities and Services: Project Development & Engineering
P.O. Box 30001
Las Cruces, New Mexico 88003

May 22, 2023

This document was prepared under the supervision and direction of the undersigned whose seal as a Professional Engineer, licensed to practice as such in the State of New Mexico, is affixed below.

Paul J. Pompeo, P.E.

11490 — NMPE Number

05/22/2023 — Date

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GEOTECHNICAL INVESTIGATION REPORT

NEW MEXICO STATE UNIVERSITY
BIOMEDICAL RESEARCH BUILDING EXPANSION

LAS CRUCES, NEW MEXICO

MAY 22, 2023

1.0 Introduction

Souder, Miller and Associates (SMA) was retained by Ms. Ashley Burkholder of the Project Development and Engineering Department of New Mexico State University to conduct a subsurface investigation and prepare the following geotechnical report. From the site's subsurface investigation through performance of soil test borings, the nature of the substrata soils will be determined, and its characteristics ascertained. The information outlined within this report may then be used for building foundation designs for the proposed building expansion and associated aviary. A project location map and bore location map are included in Appendix G.R.1.

2.0 Scope of Work

The intent of the investigation is to provide recommendations for earthwork and foundation system design for the proposed Biomedical Research Building expansion and associated aviary. The extent of this subsurface study included the drilling of four soil test borings and the laboratory testing of the soil samples collected from the site. All testing and drilling were completed by technicians from the drilling and soils testing subcontractor, Southwest Engineering, Inc. Further discussion of the findings is in Section 6.0. Also included are:

- A review of test procedures
- An evaluation of site and subsurface conditions
- Boring logs and laboratory test results
- Earthwork recommendations
- Foundation design recommendations

3.0 Site Description

A review of the project site was made by SMA personnel and the Client prior to drilling operations to document the current site conditions and characteristics. The project site is located in the southwest portion of the New Mexico State University campus at 3080 S. Espina Street in Las Cruces, New Mexico. The north portion of Neale Hall will be demolished to allow for the Biomedical Research Building expansion. The project site and adjacent properties have previously been developed into an institutional campus that encompasses single and multi-story facilities with landscaping. Development of the site includes building demolition, site clearing, grading, installation of underground utilities, and construction of buildings and drainage control features.

4.0 Investigation Procedures

The general field procedures employed by SMA are summarized in ASTM Specification D420 entitled "Standard Guide for Site Characterization for Engineering Design and Construction Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and groundwater conditions. These methods include geophysical and in situ methods as well as borings.

A CME-85 Drilling Rig, mounted on a Kenworth T800, equipped with hollow-flight augers, penetration and soil sampling equipment was used on this project. Borings are drilled to obtain subsurface samples using one of three alternate techniques depending upon the subsurface conditions. These techniques are continuous 2¼ or 8¼ inch I.D. hollow stem augers, wash borings using roller cone or drag bits (mud or water) or continuous flight augers (ASTM D1452). These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by the SEI Chief Driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observation of groundwater. It also contains the driller's interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information.

The soil and rock samples plus the field boring records are reviewed by the engineering staff at SMA. The staff classifies the soils in general accordance with the procedures outlined in ASTM Specification D2488 and prepares the final boring records which are the basis for all evaluations and recommendations. The final test boring records represent our interpretation of the contents of the field records based on the results of the engineering examination and test of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at the boring locations. Also, the passage of time may result in a change in the subsurface soil and groundwater conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The actual transition between materials may be gradual. The boring records are included in Appendix G.R.2.

The borings were drilled using hollow-stem augers. Penetration testing and split barrel sampling were conducted in the borings at regular intervals.

The standard penetration test (SPT) provides an indication of the soil strength and compressibility. The SPT resistances and split barrel sampling are conducted simultaneously according to ASTM Specification D1586. At regular intervals, the drilling tools are removed, and soil samples obtained with a standard split tube sampler. The sampler is first seated six inches, to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling thirty inches. The number of hammer blows required to drive the sampler the final foot is recorded and is designated the "penetration resistance".

5.0 Subsurface Conditions

The subsurface condition of the project area was determined from four soil test borings. The boring locations were selected by the Client after a review of the project site. Four soil test borings were located within the project site and were drilled to a depth of 25 feet below ground surface. The boring locations are shown on the Bore Location Map in Appendix G.R.1.

Standard Penetration Tests were conducted in the borings at intervals in general accordance with ASTM D1586. Disturbed samples were obtained during this test and were used to classify the soils. The standard penetration resistances obtained provide a general indication of soil strength and compressibility.

The subsurface conditions encountered are shown in the boring logs in Appendix G.R.2. These records represent our interpretation of the subsurface conditions based on field logs, visual examination of field samples, and laboratory testing of representative field samples. The lines designating the interface between various strata on the boring logs represent the approximate interface location. In reality, the transition between strata may actually be gradual.

5.1 Soil and Rock Conditions

Soil and rock conditions based on boring logs and laboratory results are presented in this section. The soil profile of the test holes shows the following:

Boring B1		
Depth (feet)	Soil Description	Soil Classification
0.0–2.5	Sandy Silt	ML
2.5–5.0	Sandy Silt	ML
5.0–7.5	Sandy Silt	ML
7.5–10.0	Silty Sand	SM
10.0–15.0	Silty Sand	SM
15.0–20.0	Silty Sand	SM
20.0–25.0	Silty Clay	CL-ML
25.0–26.5	Silty Clay with Sand	CL-ML

5.1 Soil and Rock Conditions (continued)

Boring B2		
Depth (feet)	Soil Description	Soil Classification
0.0–2.5	Silty, Clayey Sand with Gravel	SC-SM
2.5–5.0	Lean Clay with Sand	CL
5.0–7.5	Silty Gravel with Sand	GM
7.5–10.0	Silty Sand	SM
10.0–15.0	Silty Sand	SM
15.0–20.0	Silty Sand	SM
20.0–25.0	Silt with Sand	ML
25.0–26.5	Sandy Silt	ML

Boring B3		
Depth (feet)	Soil Description	Soil Classification
0.0–2.5	Sandy Silt	ML
2.5–5.0	Lean Clay	CL
5.0–7.5	Sandy Silt	ML
7.5–10.0	Poorly Graded Sand with Silt and Gravel	SP-SM
10.0–15.0	Silt with Sand	ML
15.0–20.0	Silty Sand	SM
20.0–25.0	Sandy Silt	ML
25.0–26.5	Silty Sand	SM

5.1 Soil and Rock Conditions (continued)

Boring B4		
Depth (feet)	Soil Description	Soil Classification
0.0–2.5	Silty Sand	SM
2.5–5.0	Sandy Lean Clay	CL
5.0–7.5	Silty Sand with Gravel	SM
7.5–10.0	Silty Sand	SM
10.0–15.0	Silty Sand	SM
15.0–20.0	Silty Sand	SM
20.0–25.0	Silty Sand	SM
25.0–26.5	Silty Sand	SM

Solid rock formations were ***NOT*** encountered within the borings during the field exploration on this project site.

5.2 GROUNDWATER

Groundwater was ***NOT*** encountered within the borings during the field exploration on this project site.

5.3 SOIL CHEMISTRY

No laboratory tests were performed to determine the chemical properties of the surface soils within the project area, although record data was reviewed to determine the general soil properties. Soil properties were determined from soil survey information accessed on-line via the United States Department of Agriculture Web Soil Survey at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. The soil(s) found within the project location are as follows:

Soil Chemistry Summary						
Soil Type	Soil Name	Hydrologic Soil Classification	pH	Salinity (mmhos/cm)	Risk of Corrosion Untreated Steel	Risk of Corrosion Concrete
Pa	Pajarito Fine Sandy Loam	A	7.4 to 8.4	0 to 2.0	Moderate	Low

In accordance with ASTM C150 and C150M as well as a review of soil types, Type I or Type IA cement can be used for most concrete foundations. If drainage structures are anticipated to have moderate to high sulfate concentrations, Type II cement should be used.

6.0 Discussion and Recommendations

6.1 General Project Criteria

The primary objective of this report was to review the in-situ soils located beneath and within the vicinity of the project site and provide recommendations for earthwork and foundation design for the proposed building expansion and associated aviary building. The site is south of the main biomedical research building.

6.2 General Earthwork Recommendations

Results from the subsurface investigation of the project site found that soils are predominately classified as soft to stiff sandy silts, very soft to firm clays and silty clays, and very loose to firm silty sands and gravels within the vicinity of the proposed building and adjacent aviary building. Due to low SPT values, soils within the project area are prone to consolidation and hydro-consolidation, which will lead to unacceptable levels of differential settlement.

SMA anticipates that an additional 1 foot to 2 feet of imported engineered fill will be installed in order to achieve design finished grade elevations. As such, it is recommended that earthwork improvements be completed in an effort that generates a 5-feet deep prism of densified soils beneath all slabs and foundations. The 5-feet deep prism of densified soils can be achieved by moisture treating and compacting imported engineered fill placed in appropriate lifts and in accordance with this section and Section 7.0. Clay materials encountered within this area during the general earthwork activities shall be disposed of upon completion of excavation.

In the vicinity of Boring B1, the surficial soils are silt materials. The silt materials may be combined with imported granular material and soil-blended to meet engineered fill requirements as defined in Section 7.0. In addition, in the vicinity of Boring B4, the top layer (approximately 2 feet) of native soils is classified as a silty sand and meets the requirements for engineered fill. If onsite soils are used for engineered fill, the Contractor shall verify that the soils meet the requirements for engineered fill during construction.

In all areas, the fill zone must extend a minimum of 10.0 feet beyond building foundation systems. Once the subgrade materials have been installed to the above requirements, the proposed structure can bear directly on these materials.

Fill and/or backfill materials if required and as a minimum, shall meet the requirements set forth in Section 7.0 and shall be placed in compacted layers not to exceed 6 inches in thickness. All fill materials shall be moisture treated to a level of +/- 2 percent of optimum and compacted to 95 percent of ASTM D1557. The top layer of native material below any excavated area shall be scarified, moisture treated to a level of +/- 2 percent of optimum and compacted to 95 percent of ASTM D1557.

6.3 FOUNDATION SYSTEM RECOMMENDATIONS

Foundation selection must satisfy two basic, independent criteria. First, the bearing pressure that is transmitted to the foundation soils, which includes the surcharge loads that are a result of the placement of existing and proposed fill materials, should not exceed an allowable bearing pressure. This allowable bearing pressure applies an adequate factor of safety that is applied to the soil shear strength. Secondly, the settlement due to consolidation of the underlying soils during the operating life of the structure must be within tolerable limits.

Based upon review of the geotechnical borings, the provided drilling plan, and preliminary foundation loadings provided by the project Structural Engineer, SMA has prepared recommendations for foundation design for the proposed one-story building and associated aviary. The Structural Engineer provided maximum column loads of 80 kips and maximum continuous footing loads of 4 kips per linear foot. Loose and very loose materials found within the upper 25 feet of the project area are insufficient for supporting the anticipated loadings. Historically collected data obtained within the southwestern portion of NMSU's campus and within the vicinity of the proposed project area has revealed very loose materials extending to depths ranging from 40 feet to 45 feet below existing grade surfaces at which point densified sand and sandy gravel materials are present. As such, these existing site materials, without proper mediation, have resulted in significant differential settlement issues and were taken into consideration when providing recommendations for the proposed Biomedical Research Building Expansion and associated aviary.

As part of this evaluation, allowable foundation loadings will be provided to complete recommendations. The Structural Engineer will utilize the allowable foundation loadings and shall be responsible for the final design of the building's foundation systems.

6.3.1 PROPOSED BIOMEDICAL RESEARCH BUILDING EXPANSION AND ASSOCIATED AVIARY

6.3.1.a Deep Foundation System

For the proposed foundation system associated with the proposed one-story building expansion and the associated aviary, SMA recommends the installation of auger cast-in-place (ACIP) piles for this site due to ease of installation and limited vibration during the installation process. The anticipated piles shall be installed extending to minimum depths ranging between 40 feet and 45 feet below existing site grade. Piles shall be 2-feet nominal diameter with the installation of an upper rebar cage installed during placement.

For structural considerations, these piles are considered to have an allowable capacity of 45 tons when acting as a single pile. After preliminary placement of the piles beneath the proposed surface foundation systems, those locations shall be reviewed to determine the effects of pile groups, as applicable. An industry design guide for auger cast-in-place piles is included in Appendix G.R.6.

6.3.1.b Interior Slab Foundation System

Interior slabs, not exceeding total loads of 1,000 psf, for standard loaded office slabs constructed within the building footprint are recommended to be reinforced concrete slabs. The concrete slabs should be installed independent of the structural frame and foundation systems.

6.4 *Soil Modulus Spring Constant*

Under the premise that granular materials have been utilized and mediated as per the earthwork recommendations provided in Sections 6.2 and 7.0, SMA recommends utilizing a soil modulus spring constant of 150 lb/in^3.

6.5 *Uplift/Tension Loads*

Uplift loads will be resisted only by the weight of structure and corresponding foundation design. Tension loads are not anticipated for this project.

6.6 *Lateral Loads & Retaining Structures*

The fill and/or backfill soils to be used on this project shall be cohesionless and follow the requirements of Section 7.0. Granular engineered fill shall be used behind any retaining structures. In areas that require drainage material adjacent to retaining structures and foundation systems, refer to the gradation requirement under Drainage Material specifications in Section 7.0. The following values will be used for the design of retaining structures within the project area, as applicable.

Retaining Structure Design Parameters	
Allowable Bearing Capacity	1,500 psf
Soil Unit Weight[(1)]	118 pcf
Cohesion	0 psf
Soil Angle of Internal Friction [(2),(4)]	30º
Coefficient of Friction (Soil to Concrete) [(3)]	0.25
Active Earth Pressure (level backfill) [(5)]	40 pcf
Passive Earth Pressure (level backfill) [(5)]	354 pcf
At Rest Earth Pressure (level backfill) [(5)]	59 pcf
Active Earth Pressure (sloped backfill) [(5),(6)]	44 pcf

(1) – From historical Proctor information of the surrounding area.
(2) – From "Foundation Analysis and Design" by Bowles
(3) – From the International Building Code (2015), Table 1806.2
(4) – Friction factor may not be combined with passive pressure.
(5) – Since backfill is granular material, values for drained and undrained conditions are considered equivalent.
(6) – Sloped backfill is assumed to be at 4:1 slope.

6.7 *Seismic Loads*

Seismic design considerations follow the requirements of the 2015 NEHRP Provisions. Design values are obtained from the website, "Seismic Design Maps" (https://seismicmaps.org/), developed by SEAOC and OSHPD based on United States Geologic Survey seismic design data.

Site Location Information		
Risk Category(1)	III	
Site Soil Classification (2)	C	
Location	Latitude	Longitude
	32.27967°	-106.75563°
Seismic Design Parameters (g)		
S_S	S_{MS}	S_{DS}
0.279	0.362	0.242
S_1	S_{M1}	S_{D1}
0.093	0.139	0.093

(1) – From the International Building Code (2015), Table 1604.5
(2) – Based on Shear Wave Velocity Test performed onsite on July 16, 2020.

The above site soil classification was determined by a site-specific seismic shear wave velocity test that was performed for the main portion of the Biomedical Research Building. This test was completed by Geolines, LLC on July 16, 2020. The surface wave profile extended to a depth of 100 feet. Surface waves were measured utilizing standard p-wave geophones to complete a geophone array. The calculated average shear wave velocity was 1,217 ft/s. As such the Site Soil Classification is C as presented in the 2015 IBC. The final report prepared by Geolines, LLC detailing the procedures and results of the shear wave velocity test is included in Appendix G.R.7.

6.8 SITE DRAINAGE

The final site drainage patterns are generally to the northwest in a mild form. Final site development shall be such that water from storm events will not be allowed to saturate soils under or adjacent to foundation systems. Positive surface drainage shall be maintained ***at all times*** away from the structures with a minimum slope of 0.5 percent for concrete, 1.0 percent for asphalt pavement areas, and 2.0 percent for earthen ground cover areas.

6.9 SETTLEMENT EVALUATION

Based on the soil properties found within the project site and the anticipated foundation loads, the following settlement values have been estimated for site development options using conventional foundation systems.

Estimated Settlement Values	
Estimated Total Settlement	1.5 ± inches
Estimated Differential Settlement	0.75 ± inches

These values assume that all earthwork construction within the project site meets the minimum specifications outlined in Section 7.0. As with most soils, any intrusion of water into the subgrade below foundations will cause a reduction in bearing capacity. The actual rate of decrease varies widely depending on the type of soil. This loss of bearing capacity can lead to differential settlement of the structure and could ultimately lead to failure. For these reasons, the final site areas shall be developed to account for proper drainage as outlined in Section 6.8.

7.0 Recommended Earthwork Specifications – Small Projects

7.1 GENERAL

7.1.1 Description of Work

A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for general earthwork construction including, but not limited to, the following:
   1. Site preparation.
   2. Excavation.
   3. Underpinning.
   4. Filling and backfilling.
   5. Grading.
   6. Soil Disposal.
   7. Clean Up

7.1.2 Definitions

A. Unsuitable Materials:
   1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 3 inches; organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit exceeding 35 and a plasticity index exceeding 15. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by ASTM D1557.
   2. Existing Subgrade (Except Footing Subgrade): Same materials as 7.1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proof-rolling, or similar methods.
   3. Existing Subgrade (Footings Only): Same as 7.1.2.A.1, but no fill or backfill. If materials differ from design requirements, excavate to acceptable strata subject to the Geotechnical Engineer's approval.

B. Building Earthwork: Earthwork operations required in area enclosed by a line located 5 feet outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.

C. Trench Earthwork: Trench work required for utility lines.

D. Site Earthwork: Earthwork operations required in area outside of a line located 5 feet outside of principal building perimeter and within new construction area with exceptions noted above.

E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1557, ASTM D2167, and ASTM D6938.
F. Fill: Satisfactory soil materials used to raise existing grades. In the project construction documents and drawings, the term "fill" means fill or backfill as appropriate.
G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the Project Engineer.
I. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular fill.
J. Structure: Buildings, foundations, slabs, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
K. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
L. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

7.1.3 Applicable Publications

A. The latest edition of the publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
B. American Society for Testing and Materials (ASTM):
D1557 .....Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2700 kN m/m3))
D2167 .....Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2487 .....Standard Classification of Soil for Engineering Purposes (Unified Soil Classification System)
D6938 .....Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

7.2 PRODUCTS

7.2.1 Materials

A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
B. Fill: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, and SC, or any combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off-site sources having a minimum dry density of 110 pcf, a maximum Plasticity Index of 15, and a maximum Liquid Limit of 35.
C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 1 1/2-inch sieve and not more than 35 percent passing a No. 200 sieve, per ASTM D2940.

D. Drainage Material (three-quarter inch minus aggregate backfill): Crushed rock or gravel, and sand with the gradation requirements below:

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 – 50
No. 200	0 – 12

7.3 EXECUTION

7.3.1 Site Preparation

A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions.

B. Grubbing: Remove stumps and roots 3 inch and larger diameter. Undisturbed sound stumps, roots up to 3-inch diameter and nonperishable solid objects a minimum of 3 feet below subgrade or the bottom of foundation, slabs and pavements.

C. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations.

7.3.2 Excavation

A. Shoring, Sheeting and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the Geotechnical Engineer, banks of excavations to protect workmen, banks, adjacent paving, structures and utilities.
   1. Design of the temporary support of excavation system is the responsibility of the Contractor.
   2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the Geotechnical Engineer.
   3. Extend shoring and bracing to a minimum of 5 feet below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
   4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall provide a concrete footing, under disturbed foundations, as directed by Geotechnical Engineer, at no additional cost to the Owner. Do not remove shoring until permanent work in excavation has been inspected and approved by Geotechnical Engineer.

B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from Geotechnical Engineer. If the excavation becomes saturated, approval by the Geotechnical Engineer is also required before placement of the permanent work on all subgrades.

C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the Geotechnical Engineer.

D. Building Earthwork:
   1. Excavation shall be accomplished as required by drawings and specifications.
   2. Excavate foundation excavations to solid undisturbed subgrade.
   3. Remove loose or soft materials to a solid bottom.
   4. Fill excess cut under footings or foundations with properly compacted engineered fill.
   5. Do not tamp earth for backfilling in footing bottoms, except as specified.
   6. Slope grades to direct water away from excavations and to prevent ponding.

E. Trench Earthwork:
   1. Utility trenches:
      a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
      b. Grade bottom of trenches with bell holes scooped out to provide a uniform bearing.
      c. Support piping on undisturbed earth unless a mechanical support is shown.

F. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities and other items indicated to be removed; together with soil, boulders and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by the project drawings and specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements and for inspections. Remove subgrade materials that are determined as unsuitable by this specification and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the Geotechnical Engineer shall obtain samples of the material and determine the soil classification for each sample to determine whether it is unsuitable or not.
   1. Site Grading:
      a. Provide a smooth transition between adjacent existing grades and new grades.
      b. Cut out soft spots, fill low spots and trim high spots to comply with required surface tolerances.
      c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed.

7.3.3 Filling and Backfilling

A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or damp-proofing applied, foundation drainage and pipes coming in contact with backfill have been installed and work inspected and approved by the Geotechnical Engineer.

B. Placing: Place materials in horizontal layers not exceeding 6 inches in compacted depth for material compacted by heavy compaction equipment, and not more than 4 inches in compacted depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen or contain frost.

C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 10 feet of new or existing building walls without prior approval of Geotechnical Engineer. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Compact soil to not less than the following percentages of maximum dry density, according ASTM D1557 as specified below:
   1. Fills, Embankments, and Backfill
      a. Under proposed structures, building slabs, steps and paved areas, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material to 95 percent of ASTM D1557 at a moisture range of +/- 2% of optimum.
      b. Landscaped areas to 90 percent of ASTM D1557 at a moisture range of +/- 2% of optimum.
   2. Natural Ground (Cut or Existing)
      a. Under building slabs, steps and paved areas, top 6 inches of compacted material to 95 percent of ASTM D1557 at a moisture range of +/- 2% of optimum.

D. Construction Material Testing
   1. Proctor Testing
      a. A Proctor Test shall be completed in accordance with ASTM D1557 standards to determine applicable moisture to density relationship per each soil type located within the project area.
   2. Density Testing Frequency
      a. Soils placed during mass earthwork operations located directly under building foundation systems and/or retaining wall systems shall have one density test performed per every 250 square yards of area per lift.
      b. Soils directly under building foundation systems and/or retaining wall systems shall have one density test performed per every 150 linear feet of foundation per lift.
      c. Soils located directly under site pavement areas shall have one density test performed per every 500 square yards of area per lift.

d. Soils not located under building pads or pavement areas shall have one density test performed per every 1,000 square yards of area per lift.
e. Soils utilized for trench backfill shall have one density test performed per every 150 linear feet of trench per lift.

7.3.4 Grading

A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with SM, SM-SP, or SP.
C. Slope backfill outside building away from building walls for a minimum distance of 5 feet.
D. Finished grade shall be at least 6 inches below bottom line of window or other building wall openings unless greater depth is identified on architectural drawings.
E. Finish subgrade in a condition acceptable to Project Engineer at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.
H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 0.25 inches of indicated grades.

7.3.5 Disposal of Unsuitable and Excess Excavated Material

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off of the project site.
B. Place excess excavated materials suitable for fill and/or backfill on site where directed.
C. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

7.3.6 Clean Up

Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from the project site.

8.0 Limitations

SMA prepared this report for the specific project and location aforementioned in Section 1 and Section 3. SMA conducted this study using the standard level of care and diligence normally practiced by recognized engineering firms now performing services of a similar nature under similar circumstances. This report, including all illustrations, is intended to be used in its entirety.

This report describes SMA's findings and conclusions about subsurface conditions at the locations identified and has based interpretation of the soil and groundwater conditions on data obtained from the borings drilled for this study. Although SMA has allowed for minor variations in subsurface conditions, recommendations may not be appropriate if soil conditions change or are found to

significantly vary (as a result of localized geologic conditions) from those encountered during site evaluation. SMA recommends informing and retaining SMA if unanticipated soil conditions are encountered during construction and, if necessary, revise these conclusions.

SMA prepared this report for the exclusive use of the Client and the project engineering team affiliated with this specific project. The purpose is to evaluate the design of the project as it relates to SMA's interpretation of the geotechnical aspects discussed here***. This report should be available to potential contractors for information only and not as a warranty of subsurface conditions***.

Appendix G.R.1

Project Vicinity & Bore Location Maps

SMA
Engineering
Environmental
Geomatics

SOUDER, MILLER & ASSOCIATES
3500 Sedona Hills ParkwayLas Cruces, NM 88011
Phone (575) 647-0799 Toll Free (800) 647-0799 Fax (575) 647-0680

VICINITY MAP

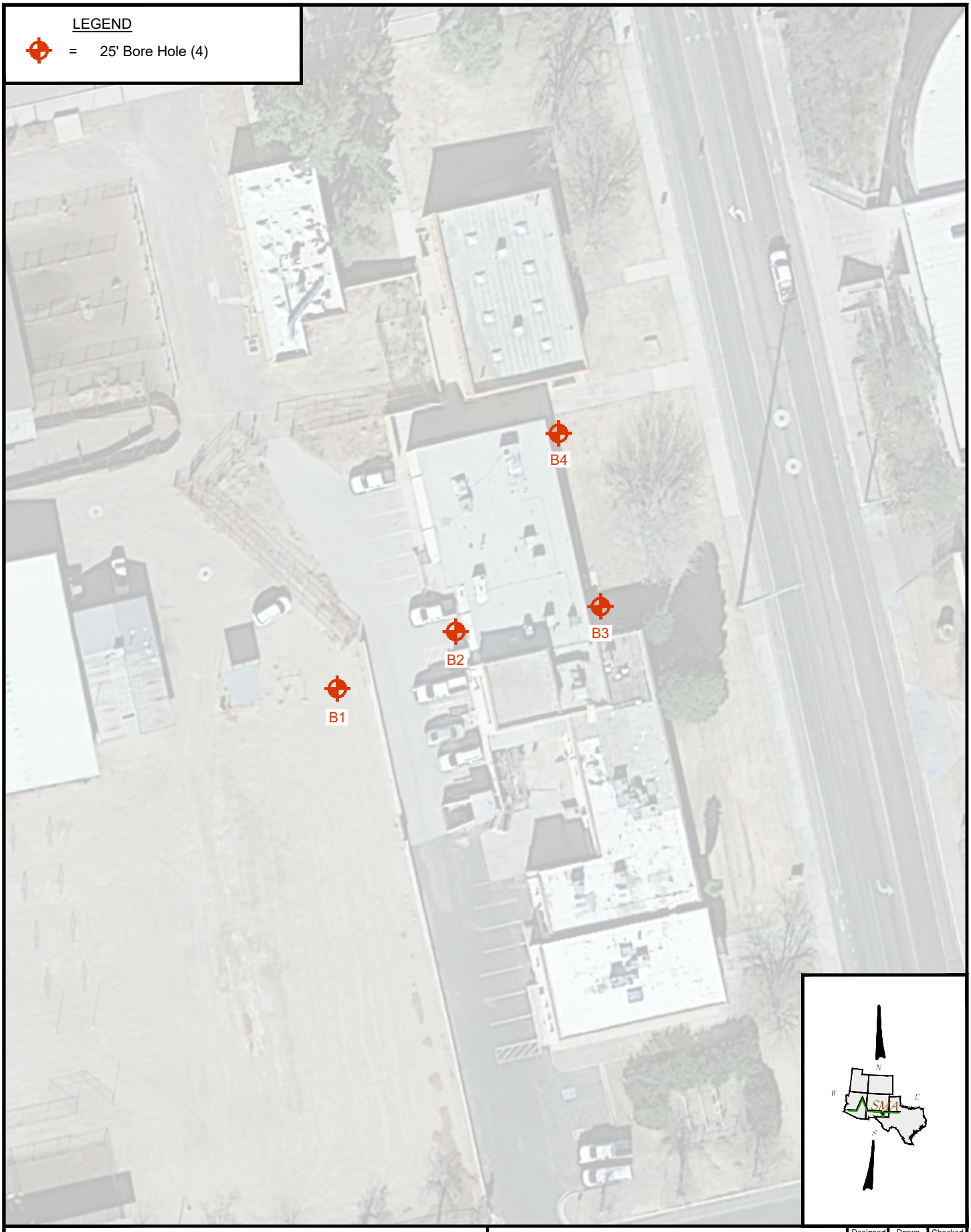
NMSU BIOMED EXPANSION PHASE III
LAS CRUCES, NEW MEXICO

Designed	Drawn	Checked
JLH	AXA	PJP

Date: 04/25/2023
Scale: 1' = 500'
Project No: 9332238

V-1

P:\9-NMSU Biomed Exp Ph II (9332238)\CAD\Civil\Phase III\Vicinity Map.dwg, AXA, 4/25/2023 12:42 PM



SMA
Engineering
Environmental
Geomatics

SOUDER, MILLER & ASSOCIATES
3500 Sedona Hills ParkwayLas Cruces, NM 88011
Phone (575) 647-0799 Toll Free (800) 647-0799 Fax (575) 647-0680

BORE LOCATION MAP

NMSU BIOMED EXPANSION PHASE III
LAS CRUCES, NEW MEXICO

Designed	Drawn	Checked
JLH	AXA	PJP

Date: 04/25/2023
Scale: 1' = 50'
Project No: 9332238
BM-1

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Appendix G.R.2

Soil Boring Logs

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B1 - page 1
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				6.9.4					
0			S	13	NP	NP	6.6	ML	Brown sandy silt
1									
2				2.2.2					
2.5			S	4	NP	NP	9.1	ML	Brown sandy silt
3									
4				3.2.3					
5			S	5	NP	NP	7.7	ML	Brown sandy silt
6									
7				3.3.2					
7.5			S	5	NP	NP	7.1	SM	Brown silty sand
8									*Trace amount of clay
9				4.4.6					
10			S	10	NP	NP	4.4	SM	Brown silty sand
11									
12									
13									
14				4.4.4					
15			S	8	NP	NP	7.6	SM	Brown silty sand
16									
17									
18									
19									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B1 - page 2
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.3.3					
20			S	6	22	4	15.6	CL-ML	Brown silty clay
21									
22									
23									
24				3.3.2					
25			S	5	22	4	17.4	CL-ML	Brown silty clay with sand
26.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B2 - page 1
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				6.4.3					
0			S	7	20	6	9.0	SC-SM	Dark brown silty clayey sand with gravel
1									
2				2.1.1					
2.5			S	2	26	9	18.7	CL	Dark brown lean clay with sand
3									
4				2.1.1					
5			S	2	NP	NP	6.9	GM	Dark brown silty gravel with sand
6									*Trace amount of clay
7				4.3.2					
7.5			S	5	NP	NP	6.5	SM	Brown silty sand
8									
9				2.2.2					
10			S	4	NP	NP	7.8	SM	Brown silty sand
11									
12									
13									
14				3.3.3					
15			S	6	NP	NP	7.9	SM	Brown silty sand
16									*Trace amount of clay
17									
18									
19									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B2 - page 2
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.3.4					
20			S	7	NP	NP	14.7	ML	Brown silt with sand
21									*Trace amount of clay
22									
23									
24				4.3.3					
25			S	6	NP	NP	16.4	ML	Brown sandy silt
26.5									*Trace amount of clay

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B3 - page 1
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				5.8.8					
0			S	16	NP	NP	10.3	ML	Brown sandy silt
1									
2				3.3.3					
2.5			S	6	24	9	10.1	CL	Brown lean clay
3									
4				3.3.3					
5			S	6	NP	NP	8.4	ML	Brown sandy silt
6									*Trace amount of clay
7				7.7.6					
7.5			S	13	NP	NP	2.4	SP-SM	Brown poorly graded sand with silt and gravel
8									
9				2.2.3					
10			S	5	NP	NP	11.3	ML	Brown silt with sand
11									*Trace amount of clay
12									
13									
14				4.4.6					
15			S	10	NP	NP	7.2	SM	Brown silty sand
16									
17									
18									
19									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B3 - page 2
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.3.5					
20			S	8	NP	NP	9.3	ML	Brown sandy silt
21									*Trace amount of clay
22									
23									
24				4.5.5					
25			S	10	NP	NP	9.1	SM	Brown silty sand
26.5									*Trace amount of clay

Sample Type

D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B4 - page 1
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				8.15.14					
0			S	29	NP	NP	2.6	SM	Brown silty sand
1									
2				5.4.4					
2.5			S	8	31	16	9.7	CL	Brown sandy lean clay
3									
4				4.4.5					
5			S	9	NP	NP	3.2	SM	Brown silty sand with gravel
6									
7				3.3.2					
7.5			S	5	NP	NP	4.7	SM	Brown silty sand
8									
9				2.2.4					
10			S	6	NP	NP	5.8	SM	Brown silty sand
11									
12									
13									
14				2.4.4					
15			S	8	NP	NP	5.1	SM	Brown silty sand
16									
17									
18									
19									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	NMSU Biomed Expansion Ph II	Date of Field Operations	8-May-23
Project Number	43009	Laboratory Number	B4 - page 2
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				4.3.3					
20			S	6	NP	NP	7.0	SM	Brown silty sand
21									
22									
23									
24				4.4.4					
25			S	8	NP	NP	9.2	SM	Brown silty sand
26.5									*Trace amount of clay

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

No Groundwater Encountered

Appendix G.R.3

Laboratory Analysis

APPENDIX G.R.3 - LABORATORY ANALYSIS

SAMPLE HANDLING

After recovery, our engineering staff removed the soil samples from the samplers in field. They examined the samples, visually classified them, and preserved representative portions of each sample for laboratory testing. They also obtained strength estimates of most cohesive samples in the field using a calibrated hand penetrometer or a Torvane.

SOIL CLASSIFICATION

Soil Classifications provide a general guide to the engineering properties of various soil types. Representative samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our Test Boring Records.

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and index tests. Using these test results the soil can be classified according to the AASHTO, FAA, or Unified Classification Systems (ASTM D2487). These soil classifications and the in-place physical soil properties provide and index for estimating the behavior of the soil.

GRAIN SIZE TESTS

Grain size tests are performed to determine the distribution of particle sizes. The soil samples are prepared for testing according to ASTM D421 (dry preparation) or ASTM D2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Usually, these are sandy or gravelly soils. Materials passing the No. 200 sieve are the percent fines (silt and clay sizes). Using a hydrometer, these particles are suspended in water and the particle size distribution calculated from the measured settlement rate.

INDEX TESTING

Index tests are performed to determine the soil classification and plasticity characteristics. Generally, index tests are conducted on clayey and silty soils. The soil plasticity characteristics are defined by the Plastic Limit (PL) and the Liquid Limit (LL). The PL and LL are determined in accordance with ASTM D4318 and are referred to as the Atterberg Limits.

PHYSICAL SOIL PROPERTIES

The in-place physical properties are described by the specific gravity, wet unit weight, moisture content, dry unit weight, void ratio, and percent saturation of the soil. The specific gravity and moisture content are determined according to ASTM D854 and D2216, respectively. The wet unit weight is found by obtaining a known volume of the soil and dividing the wet sample weight by the known volume. The dry unit weight, void ratio and percent saturation are calculated values.

SOUTHWEST ENGINEERING, INC.

TABULATION OF LABORATORY LAB RESULTS

PROJECT: NMSU Biomed Expansion Ph II

PROJECT#: 43009

CLIENT: Souder, Miller & Assoicates

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B1	0.0 - 2.5	6.6						100	98	96	89	73	60.5	NP	NP	ML
	2.5 - 5.0	9.1							100	100	96	82	66.2	NP	NP	ML
	5.0 - 7.5	7.7								100	95	76	59.9	NP	NP	ML
	7.5 - 10.0	7.1								100	89	58	40.7	NP	NP	SM
	10.0 - 15.0	4.4			100	97	92	90	86	83	66	33	19.8	NP	NP	SM
	15.0 - 20.0	7.6					100	99	99	97	87	53	38.5	NP	NP	SM
	20.0 - 25.0	15.6								100	99	97	93	4	22	CL-ML
	25.0 - 26.5	17.4					100	99	98	97	96	91	82.6	4	22	CL-ML

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B2	0.0 - 2.5	9.0			100	97	91	87	77	67	52	40	32.8	6	20	SC-SM
	2.5 - 5.0	18.7				100	99	99	98	97	91	79	70.5	9	26	CL
	5.0 - 7.5	6.9			100	90	79	73	57	49	32	19	14.2	NP	NP	GM
	7.5 - 10.0	6.5			100	98	98	96	89	80	53	29	20.7	NP	NP	SM
	10.0 - 15.0	7.8					100	99	93	89	71	40	28.3	NP	NP	SM
	15.0 - 20.0	7.9						100	99	99	91	56	39.5	NP	NP	SM
	20.0 - 25.0	14.7						100	99	98	96	87	78.6	NP	NP	ML
	25.0 - 26.5	16.4			100	99	98	97	96	95	91	76	64.5	NP	NP	ML

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B3	0.0 - 2.5	10.3				100	99	99	97	95	87	65	52	NP	NP	ML
	2.5 - 5.0	10.1								100	99	96	86.4	9	24	CL
	5.0 - 7.5	8.4					100	99	99	96	91	79	66.4	NP	NP	ML
	7.5 - 10.0	2.4			100	92	88	84	70	59	33	12	6	NP	NP	SP-SM
	10.0 - 15.0	11.3							100	99	95	84	72.5	NP	NP	ML
	15.0 - 20.0	7.2			100	96	96	95	94	93	85	53	35.7	NP	NP	SM
	20.0 - 25.0	9.3								100	95	73	58.4	NP	NP	ML
	25.0 - 26.5	9.1				100	98	97	95	93	85	61	46.6	NP	NP	SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B4	0.0 - 2.5	2.6				100	97	96	90	85	73	49	33.1	NP	NP	SM
	2.5 - 5.0	9.7					100	99	96	94	87	71	60.3	16	31	CL
	5.0 - 7.5	3.2			100	89	83	77	66	57	37	27	19.7	NP	NP	SM
	7.5 - 10.0	4.7			100	99	95	93	86	78	62	38	22.6	NP	NP	SM
	10.0 - 15.0	5.8				100	100	99	96	93	78	51	32.2	NP	NP	SM
	15.0 - 20.0	5.1					100	99	98	97	87	46	27.8	NP	NP	SM
	20.0 - 25.0	7.0			100	97	97	97	96	95	81	51	38.1	NP	NP	SM
	25.0 - 26.5	9.2				100	99	98	96	94	85	58	45.4	NP	NP	SM

Appendix G.R.4

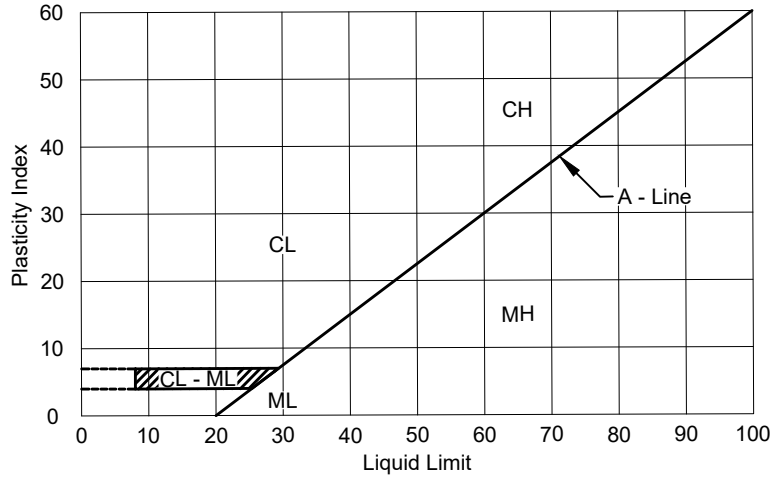
USCS Soil Classification System

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Test are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For more detailed description of the system, see "The Unified Soil Classification System", Corp of Engineers, US Army Technical Memorandum No.3-357 (revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS			GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)		GW	Well-graded gravels, gravel-sand mixtures, little or no fines
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve) — Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve) — Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (more than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)		SW	Well-graded sands, gravelly sands, little or no fines
				SP	Poorly-graded sands, gravelly sands, little or no fines
		SANDS WITH FINES (More than 12% passes No. 200 sieve) — Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures
		SANDS WITH FINES (More than 12% passes No. 200 sieve) — Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (Limits Plot Below "A" Line Δ hatched zone on plasticity chart)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50%)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CLAYS (Limits Plot Above "A" Line Δ hatched zone on plasticity chart)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50%)		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50%)		CH	Inorganic clays of high plasticity, fat clays

NOTE: Coarse grained soils with between 5% and 12% passing the No. 200 sieve and fine grained soils with limits platting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	
Above 3 Inches	
Gravel	
3 In. to No. 4 Sieve	
Coarse Gravel	3 In. to ¾ In.
Fine Gravel	¾ In. to No. 4 Sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (Silt or Clay)	Below No. 200 Sieve

SMA
Engineering
Environmental
Geomatics

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UNIFIED SOIL CLASSIFICATION SYSTEM

Designed	Drawn	Checked
SVG	SVG	PJP

Date: JAN. 2018
Scale: 1" = 1'
Project No:
SHEET - 1

Appendix G.R.5

Correlation of Penetration Resistance With Relative Density and Consistency

APPENDIX G.R.5

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

(Table 5.3 from Foundation Engineering, 2ND Edition, by Peck, Hanson, Thornburn)

	NO. OF BLOWS, N	RELATIVE DENSITY
	0 - 4	Very Loose
	5 - 10	Loose
Sands:	11 - 30	Firm
	31 - 50	Dense
	Over 50	Very Dense

		CONSISTENCY
	0 - 2	Very Soft
	3 - 4	Soft
Silts	5 - 8	Firm
&	9 - 15	Stiff
Clays:	16 - 30	Very Stiff
	31 - 50	Hard
	Over 50	Very Hard

PARTICAL SIZE IDENTIFICATION:

(ASTM D2487)

Boulders:	Greater than 300 mm
Cobbles:	75 mm to 300 mm
Gravel:	
Coarse -	19 mm to 75 mm
Fine -	4.75 mm to19 mm
Sands:	
Coarse -	2 mm to 4.75 mm
Medium -	0.425 mm to 2 mm
Fine -	0.075 mm to 0.425 mm
Silts & Clays:	Less than 0.075 mm

Appendix G.R.6

Industry Design Guide

PROCESS INDUSTRY PRACTICES

COMPLETE REVISION
March 2019

Structural

PIP STE02465
Augered Cast-in-Place Piles Design Guide

PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

This Practice is subject to revision at any time.

PUBLISHING HISTORY

March 2005	*Issued*
February 2012	*Complete Revision*
March 2019	*Complete Revision*

Not printed with State funds

PIP STE02465
Augered Cast-in-Place Piles Design Guide

Table of Contents

1. Scope

This Practice complements *PIP STS02465* and assists the engineer in preparation of contract documents for furnishing and installing augered cast-in-place (ACIP) piles.

This Practice is modeled on *DFI TM-ACIP-4* (Augered Cast-in-Place Piles Manual). For additional information, refer to that manual, *FHWA-HIF-07-03* (Geotechnical Engineering Circular No. 8), *DFI TM-ACIP-2* (Augered Cast-in-Place Piles Inspector's Guide), and *DFI TM-ACIP-3* (Guideline for Interpretation of Nondestructive Integrity Testing of Augered Cast-in-Place and Drilled Displacement Piles).

2. References

Applicable parts of the following Practices, industry codes and standards, and other references shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 Process Industry Practices (PIP)

- PIP STS02465 - *Augered Cast-in-Place Piles Installation Specification*
- PIP STS03001 - *Plain and Reinforced Concrete Specification*

2.2 Industry Codes and Standards

- American Concrete Institute (ACI)
  - ACI 212.3R - *Report on Chemical Admixtures for Concrete*
  - ACI 301 - *Specifications for Structural Concrete*
  - ACI 301M - *Specifications for Structural Concrete (Metric)*
- American Society of Civil Engineers (ASCE)
  - ASCE/SEI 7 - *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*
- ASTM International (ASTM)
  - ASTM A615/A615M - *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement*
  - ASTM A706/A706M - *Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement*
  - ASTM A722/A722M - *Standard Specification for High-Strength Steel Bars for Prestressed Concrete*
  - ASTM C191 - *Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle*
  - ASTM D1143/D1143M - *Standard Test Methods for Deep Foundations Under Static Axial Compressive Load*
  - ASTM D4945 - *Standard Test Method for High-Strain Dynamic Testing of Deep Foundations*
  - ASTM D5882 - *Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations*
  - ASTM D6760 - *Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing*

- ASTM D7949 - *Standard Test Methods for Thermal Integrity Profiling of Concrete Deep Foundations*

- Deep Foundations Institute (DFI)
  - TM-ACIP-2 - *Augered Cast-in-Place Piles Inspector's Guide*
  - TM-ACIP-3 - *Guideline for Interpretation of Nondestructive Integrity Testing of Augered Cast-in-Place and Drilled Displacement Piles*
  - TM-ACIP-4 - *Augered Cast-in-Place Piles Manual*
- Federal Highway Administration (FHWA)
  - FHWA-HIF-07-03 - Geotechnical Engineering Circular No. 8 – *Design and Construction of Continuous Flight Auger (CFA) Piles*

2.3 Technical Papers

- Piscsalko, G, White, B. Proceedings of the Seventh International Conference on the Application of Stresswave Theory to Piles 2004. Petaling Jaya, Malaysia; pp107-123. August 2004.

3. Definitions

constructor: Party responsible for supplying materials, equipment, tools, supervision, and labor for installation of ACIP piles in accordance with contract documents. The term constructor applies also to constructor's subcontractor(s) and vendor(s).

contract documents: Any and all documents, including codes, studies, design drawings, specifications, sketches, practices, and data sheets, that purchaser or engineer of record has transmitted or otherwise communicated, either by incorporation or reference, and made part of the legal contract agreement or purchase order between purchaser and constructor

engineer of record: Purchaser's authorized representative with overall authority and responsibility for engineering design, quality, and performance of civil works, structure, foundations, materials, and appurtenances described in contract documents. Engineer of record is licensed as defined by laws of the locality in which the work is to be constructed and is qualified to practice in the specialty discipline required for the work described in contract documents.

geotechnical engineer: Professional engineer responsible for performing geotechnical investigation and/or geotechnical consulting during foundation design, construction of civil works, installation of piling and foundations

owner: Party who has authority through ownership, lease, or other legal agreement over site, facility, structure or project wherein ACIP piles will be installed

professional engineer: A licensed engineer, other than engineer of record, qualified to practice in the specialty discipline required for the work described in contract documents

purchaser: Party who awards contract to constructor. Purchaser may be owner or owner's authorized agent.

qualified geotechnical representative: Graduate geotechnical engineer, graduate geologist, or geotechnical technician, provided technician has at least ten years of relevant field exploration and

logging experience and works under supervision of geotechnical engineer. Geotechnical engineer may also fulfill this role.

Quality Assurance (QA) representative: Party retained by purchaser responsible for review of submissions by QC inspector as well as direct observation of the work. Role may be fulfilled by qualified geotechnical representative or geotechnical engineer.

Quality Control (QC) inspector: Party responsible for verifying quality of all materials, installations, and workmanship furnished by constructor. QC inspector is qualified by training and experience and holds certifications or documentation of their qualifications. Unless otherwise specified in contract documents, QC inspector is an independent party retained by constructor.

4. General

4.1 System Description

4.1.1 ACIP piles are installed using a continuous flight auger with a hollow stem. During the drilling phase, the flights are filled with soil, maintaining the stability of the hole. When the design depth is reached, grout or concrete is forced down the hollow stem as the auger is gradually withdrawn.

4.1.2 Reinforcing is installed in the fluid grout or concrete immediately after removal of the auger; commonly the cage is installed only to partial depth for constructability reasons, as required by design for bending. Typically, a single center bar is installed full depth at the pile centerline. This single bar is often sufficient for uplift and provides some physical verification of pile continuity to design depth.

4.1.3 ACIP piles typically have diameters from 12 to 36 inches (300 to 900 mm) and lengths commonly up to 100 ft (30 m). Whereas in the past ACIP piles have been commonly used in relatively small sizes and depths, the trend is towards higher capacities, with 24 inch (600 mm) up to 42 inch (1100 mm) diameters and depths as great as 100 ft (30 m) or occasionally up to 150 ft (45 m). European practice has included up to 60 inch (1500 mm) diameter piles. Aspect (depth:diameter) ratios of more than 30 are considered to require extra care, though there have been successful installations with aspect ratios of 50 or more.

4.1.4 Compared with drilled shafts, ACIP piles offer potential advantages of faster cycle times. In ideal cohesive soil, either system would work well but ACIP piles should have a faster cycle time. Where soil conditions would require casings for drilled shafts, there is a greater potential ACIP piles have time and cost advantages. In some soils, the pressure injection of the grout may provide somewhat greater pile load capacity compared to a similar size drilled shaft. Compared with driven piles, ACIP piles have the advantage in noise and vibration where these are considerations.

4.1.5 The main disadvantage of ACIP piles is that the result is highly dependent on operator skill. In addition, it is most critical that the correct equipment is used with sufficient downward thrust (“crowd”), power and torque as needed for the pile size and geotechnical conditions. It is very critical that “soil mining” due to excessive rotation without sufficient corresponding auger penetration be avoided. ACIP pile systems cannot readily be used either in very soft and organic soils or

in mixed soil with cobbles and boulders; however, ACIP piles have been used in soft rock and weathered limestone.

4.1.6 Where clearances are limited, a variation of the ACIP piles system is low-headroom equipment. In this system, segmental augers are used. It can be competitive with micropiles, particularly to resist higher shear and bending loads. Size and depth of piles may be limited both by clearance considerations and by the size and power of the drilling equipment.

4.1.7 A variation of ACIP piles are drilled displacement (DD) piles together with hybrid systems called partial displacement piles. In these systems, the drilling tool is designed to force all or part of the soil outward, compressing the soil. These systems may offer particular advantages in sands and average to weak soil conditions. For a given size, depth and soil, DD systems require more crowd, power and torque than conventional systems. DD piles are often used in weaker soil and to depths that are more limited. For a given size, depth and soil, DD piles may develop greater capacities and will reduce or eliminate spoils. Most systems of drilled displacement or partial displacement piles include proprietary technology. See Table 6.1 in *FHWA-HIF-07-03* for comparisons of relatively favorable and unfavorable conditions for various deep foundation types.

4.1.8 For DD piles see further discussion in Section 5.1 and 6.1 below regarding modifications (overlays) needed in order to use *PIP STS02465*.

4.2 Design of ACIP Piles

For convenience in following sections of this Guide, where comparisons are made between DD piles and conventional ACIP piles, the latter will be referred to as continuous flight auger (CFA) piles.

4.2.1 Capacity of an ACIP pile, like that of other deep foundations, includes side friction and end bearing components. In general the compression capacity of ACIP piles for a given geometry and soil will fall between that of a drilled shaft and a driven pile, with CFA piles closer in capacity to drilled shafts and DD piles closer to driven piles. Pile testing should provide load-strain curves defining displacement as a function of load.

4.2.2 ACIP piles have uplift and lateral capacity similar to that of drilled shafts. However there may be practical limitations on the quantity of reinforcing bars that can successfully be placed in ACIP piles. CFA piles are subject to the same group effect considerations (both vertical and lateral) as drilled shafts; DD piles may achieve somewhat increased axial capacities when installed in groups.

4.2.3 Engineers are directed to *FHWA-HIF-07-03* for a comprehensive review of design methods for ACIP piles. This reference also provides a basis for preliminary estimation of capacity for conventional ACIP piles and DD piles in both cohesive and cohesionless subgrade material. Estimated capacities may be calculated from geotechnical data such as standard penetration tests (SPT) or cone penetrometer tests (CPT).

4.2.4 Geotechnical engineer normally determines minimum grout volume for soil stratigraphy. Typically, a minimum of 115% of theoretical grout volume is placed in each increment of pile. In some very stiff soils or soft rock, unit volume could be reduced to as little as 100%. In soft soils or soils with voids, unit grout

volume can be significantly larger. In some instances, grout head can exceed the shear capacity of soil resulting in very large grout unit volumes. In such instances, ACIP piles may not be suitable.

4.2.5 Design loads for ACIP piles should be determined in accordance with minimum load requirements described in *ASCE/SEI 7.* As for some other types of deep foundations installed through unconsolidated material, downdrag may be a load consideration.

4.2.6 Reinforcing

4.2.6.1 Normally, ACIP piles are reinforced only as required for compression, bending and uplift. Geotechnical engineer should provide p-y analysis for piles subject to bending. Piles subject to uplift often have a single full-length reinforcing bar. See *ASCE/SEI 7* for instances where full-length reinforcing cages are required in high seismic areas.

4.2.6.2 Typically, *ASTM A615/A615M* Grade 60 (420) reinforcing bars should be used. If reinforcing bars need to be welded, then *ASTM A706/A706M* Grade 60 (420) reinforcing bars should be used.

4.2.6.3 *ASTM A722/A722M* reinforcing bars should be used if high-strength is required.

4.2.6.4 Typically, ACIP pile reinforcing steel cages are designed using bars of the same length. Ideally, cages should be kept to 15 to 25 ft (4.5 to 8 m). Shortening the reinforcing steel cage to this length can help reduce construction problems and increase pile installation rates.

4.2.6.5 Cage design should consider the need for grout to freely flow between the bars. Multi-layer cages are very difficult to install and pose significant risk of defects in the form of voids between bars due to bridging of the grout or concrete. Consider using larger diameter piles with single-layer cages composed of larger diameter bars.

4.2.6.6 Normally reinforcing cover is 3 inches (75 mm), though larger cover could be considered if necessitated by poor soil conditions.

4.2.6.7 Reinforcing cages longer than 20 to 25 ft (6 to 8 m) and multi-layered cages can be difficult or impossible to install properly. If longer cages are required, structural engineer and geotechnical engineer should review the soil profile and revise minimum grout quantity and diameter to ensure proper placement.

4.2.6.8 Sufficient spacing should be provided between reinforcing bars to permit free flow of grout. If reinforcing spacing is less than five times the maximum diameter of (concrete) aggregate, bar size should be adjusted, or a larger diameter pile should be specified.

4.2.6.9 Tension piles typically use a single full-length reinforcement bar.

4.2.6.10 Longitudinal reinforcement and spiral confining steel (or suitable alternative reinforcement) can be used to withstand seismic pile-soil interaction loading/distortion conditions, particularly if these piles derive a significant share of their support in end bearing resistance during and immediately after a major earthquake.

4.2.6.11 Cage design should facilitate installation of full-length cages (e.g., bending reinforcement bars inward at bottom of cage to reduce likelihood that it will catch on sides of pile grout hole).

4.2.6.12 Constructor should provide a plan to assure that a full-length cage can be installed.

4.2.6.13 Full-length reinforcing cages can preclude the use of ACIP piles as deep piles in some soil conditions.

4.2.6.14 Requirements for hooks on reinforcing cages should be carefully evaluated as hooks can cause difficulty in placement. Pre-assembled cages with hooked bars can be difficult to fabricate, place efficiently on delivery trucks, and handle in the field.

4.2.6.15 Often, top of the pile is below ground, and hooks are field bent. Field bending of reinforcing bars is essentially limited to # 7 bars (#22 metric bars) or less. Larger bars bend more slowly and require special procedures. If limiting bar size to #7 (#22 metric) reduces clearance unacceptably, diameter of pile may need to be increased.

4.2.6.16 Bar bends should be limited to 90-degree bends.

4.2.7 Governing building codes should be checked for limitations that are more restrictive than those in *PIP STS02465*. Some building codes place specific limits on design stresses and/or maximum loads for ACIP piles. Local codes may also restrict spacing between piles constructed within 24 hours of one another, reinforcing cover, length to diameter ratio, limitations on work below the water table, etc.

5. Contract Documents

5.1 Scope

5.1.1 Contract scope-of-work documents should specify party responsible for all tasks. "Split" contracting is not advisable. Generally, constructor should be responsible for all phases of constructing ACIP piles including safety, construction permits, sourcing of materials, suitable equipment, experienced manpower, installation schedule, load testing, and other items required for successful installation. Specifically, constructor of the ACIP piles should be responsible for safety, drilling, automated monitoring, grout procurement and placement, reinforcing assembly procurement and installation, monitoring ACIP piles for grout settlement, maintaining grout level in ACIP piles, protection of ACIP piles during curing, and pile load testing.

5.1.2 The basis for *PIP STS02465* is that design of the piles, geotechnical report, and quality assurance are all tasks performed by parties engaged directly or indirectly by the Purchaser, separate from the ACIP pile installation contract. Constructor QA/QC responsibilities beyond those given in *PIP STS02465* should be noted in contract documents, including pre-construction testing, monitoring during production and post-production integrity testing.

5.1.3 Particular attention should be given to roles and responsibilities in the case that QC inspector or QA representative informs the constructor of deficiencies in pile

installation but constructor decides to complete the pile anyway. Options for resolution of this situation include rejection by the geotechnical engineer (based on the installation record), proof-load testing, and integrity testing; the contract documents should address cost liabilities for this case.

5.1.4 Where DD piles are proposed, the constructor may assume design responsibility, effectively becoming the geotechnical engineer. In this case, the contract documents must specify the basis of design including relevant governing codes, owner requirements, and load cases. Reporting, submittals, and approvals by the engineer of record should be clearly specified.

5.1.5 *PIP STS02465* may be used but will require significant modifications (overlays) for DD piles or other proprietary systems. These modifications should be agreed upon in the pre-award meeting review of exceptions (Spec item 5.2.1.t). These modifications include, but are not limited to, Design (5.3); Gear Box/Power Unit (5.6.2); Augering Equipment (5.6.3) and Installation Procedures (5.7.4) especially auger operations.

5.1.6 Interfaces with other contractors and material suppliers should be covered in contract documents.

5.2 Design Drawings

Design drawings should include scale piling plans showing pile locations, cap locations, known existing obstructions such as foundations and underground pipes. A pile numbering system should be provided for reference during construction. Details and/or schedules should provide elevations for pile tip, cutoff and grade; as well as reinforcing details. Piles are often numbered using the drawing sheet or sequence number followed by a column and row designation. Numbering should be determined early enough that it can be used for reinforcing steel to reduce confusion in the field. The numbering should also accommodate replacement or additional piles as may be required due to installation issues.

5.3 Schedule and Submittal Review

5.3.1 Desired schedule of work should be laid out in contract documents, accounting for any plans for pre- and post-production testing, as well as requirements related to limitations on adjacent piles and movement of equipment.

5.3.2 Timing of constructor submittals (if different from *PIP STS02465*) and timing of purchaser submittal reviews should be included with contract documents.

5.3.3 Requirements for progress reporting should be covered in contract documents.

5.4 Geotechnical Report

5.4.1 A geotechnical report based on a subsurface investigation is required. As for any project, geotechnical report requisition should include reasonable preliminary structural loads, locations, elevations, etc. Cone penetrometer testing can be used to supplement geotechnical soil boring program to correlate conditions across an extended site. Data requirements are essentially the same as for any similar project where deep foundations are proposed, with specific recommendations for ACIP piles.

5.4.2 Engineer of record and design engineer should review subsurface investigation and structural load report before design of piles and foundations.

5.4.3 Data from subsurface investigation(s) must be reviewed by constructor. Constructor should understand soil conditions at the site in order to provide suitable equipment to function under conditions at the site. Additional investigations may be performed at constructor's own discretion and expense with owner's approval.

5.5 Surveying

5.5.1 Contract documents should specify party responsible for survey laying out the piles and marking cut-off elevations.

5.5.2 Location of benchmarks and description of datum plane should be provided, if appropriate.

5.5.3 Contract documents should specify party responsible for survey locating as-built pile locations and elevations.

5.6 Underground Utility Location

5.6.1 Contract documents should include plans showing underground utilities nearby or adjacent to proposed foundations.

5.6.2 Contract documents should specify party responsible for identifying, locating, and marking underground utilities.

5.7 Construction Permits

5.7.1 Contract documents should specify party responsible for providing construction permits.

5.7.2 Obtaining construction permits from regulatory agencies should typically be the responsibility of constructor.

5.7.3 Construction permits that the owner/purchaser furnishes to constructor should be clearly and completely described in contract documents.

6. Specification Commentary

This Section provides a commentary on *PIP STS02465*. Section numbering generally follows the sequence of the Specification.

6.1 Specification Scope

PIP STS02465 is intended to cover conventional augered cast-in-place (ACIP) piles. Besides continuous flight auger, drilled displacement and screw piles, other terms mentioned in *DFI TM-ACIP-4* include augered cast in situ, Auger Cast Piles, Intruded Mortar Piles, Augerpress Piles, Augered Pressure Grouted Piles, AugerPile Foundations, Continuous Flight Auger (CFA) Piles, Grouted Bored Piles, Augered Grout-Injected Piles, Drilled or Augered Uncased Piles, and Uncased Cast-in-Place Concrete Piles. A number of proprietary types of ACIP piles have been developed, for which the piles are known by trade names. Some of these include partial displacement piles. As mentioned above, the extent to which overlays are required for a specific system needs to be addressed on a case-by-case basis.

6.2 Specification Definitions

Definitions in *PIP STS02465* are identical to this Practice. Geotechnical engineer is to be licensed according to laws of the locality in which work is to be constructed. QC inspector is to be an independent party retained by constructor. QA representative is retained by purchaser for review of the work.

With the use of overlays, other contractual arrangements are possible while still utilizing *PIP STS02465*. For one example, if the QC inspector is not an independent third party, responsibilities should be reviewed, possibly reassigning certain items to the QA representative.

6.3 Specification Quality Control/Assurance

PIP specifications normally locate quality requirements in Section 4. One aspect of ACIP pile installation is the need for detailed quality control and quality assurance at all stages of work, especially during actual drilling and grouting. For *PIP STS02465*, therefore, Section 4 provides a cross-reference to the many quality requirements found throughout.

6.4 Specification Requirements

6.4.1 General

6.4.1.1 *PIP STS02465* provides suggested minimum requirements for prior experience in similar work by the constructor, constructor's personnel and QC inspector. These requirements may be modified by judgment of purchaser.

6.4.1.2 Constructor is required to evaluate whether proposed equipment is fit for purpose based on soil conditions. Some soil material may require heavier-duty equipment than minimums given in *PIP STS02465*. The primary concern with underpowered equipment is "soil mining" which can occur where vertical advance of the auger does not keep up with auger rotation. Undersized equipment will also struggle to maintain production rates, often leading to schedule delays and/or cost overruns.

6.4.1.3 Constructor is required to evaluate the site to verify physical clearances for proposed equipment. Access route widths, turning radii, and overhead clearances may restrict installation sequence and require additional work to navigate. Where work by others may impact clearances (e.g. pipe bridge erection), it is important to provide as much detail as practical.

6.4.1.4 *PIP STS02465* requires a pile load test to be performed. Testing can be used to confirm or modify adequacy of equipment and drilling procedures as well as compression, tension and lateral performance. Section 5.1.12 of *PIP STS02465* provides a related requirement to follow approved installation procedures and provide notification of any change.

6.4.1.5 *PIP STS02465* provides general requirements for monitoring of work by engineer of record, geotechnical engineer and QC inspector; and requirement for notification and correction of defective work.

6.4.1.6 *PIP STS02465* enumerates general requirements for QC inspector to become familiar with all aspects of the ACIP pile installation program.

Although *PIP STS02465* covers areas for cognizance by QC inspector, these areas are likewise important to the QA representative.

6.4.1.7 *PIP STS02465* is set up in such a way that it can be used with various project organizational structures. On projects of any size, it will be necessary to set up a distribution matrix to ensure appropriate review and approval of each type of document.

6.4.2 Meetings

6.4.2.1 *PIP STS02465* includes a topic outline for required initial coordination meetings. The pre-award meeting list could be easily adapted for use for pre-bid meetings as well. The pre-construction meeting, held with the personnel responsible for the field work, covers the same basic topics. The level of detail may vary.

6.4.2.2 Two changes were made from the previous version of *PIP STS02465*: an added requirement for constructor to clarify any proposed specification modifications and exceptions; and deletion of the essentially identical separate topic list for the pre-construction meeting. It may be prudent to revisit many of these topics during the pre-construction meeting using the original listing; as a minimum, any changes or new information since the pre-award meeting should be highlighted.

Comment: See *DFI TM-ACIP-2* for more information and commentary on the pre-construction meeting.

6.4.2.3 Safety topics may include, but not limited to, crane safety inspections, operating procedures, operator experience and qualifications, special hazards, etc.

6.4.2.4 It is recommended to hold discussion of schedule to the end of the meetings to ensure all the technical topics are properly covered.

6.4.3 Design

PIP STS02465 states that design will be furnished to constructor; therefore, no design requirements are provided. See Section 4.2 above and *FHWA-HIF-07-03* for design procedures. In the case of constructor providing the design, loads and load cases will need to be developed; and the reference above may be used as a basis for review by the geotechnical engineer.

6.4.4 Submittals

6.4.4.1 Pre-construction Submittals

PIP STS02465 provides a list of submittals to pin down the equipment, procedures and materials to be used. The submittals should help confirm constructor's mastery of the specific task and provide the basis for a detailed execution plan. A couple of items may be of particular interest. Item (i.) is a complete pile installation procedure, spelling out expectations for auger rotation speed, drilling penetration rate, torque and dead weight, grout pressure and grout volume factor. Item (n.) includes automated monitoring parameters and a sample of the printed output.

6.4.4.2 Construction Submittals

PIP STS02465 provides requirements for record keeping by QC inspector for each individual pile, and provides US and metric data forms suitable for this purpose. Requirements are provided for distribution of the collected information. As an option, purchaser could elect not to require collection of certain "incremental data" (e.g. grout volume in each 5 ft (1.5m)) that is captured by the automated monitoring equipment, if it is judged that QC inspector's attention is best focused otherwise.

6.4.4.3 Automated Instrumentation and Monitoring Submittals

Requirements are found in several places in *PIP STS02465*. Section 5.4.3 establishes the content and format of automated instrumentation and monitoring submittals. Section 5.4.2.4 and related sections provide for the pile-by-pile data collection and dissemination of information, including automated monitoring data. Section 5.6.1 provides technical requirements for the automated data recording equipment, including minimum data collection requirements (described in its corresponding section of this guide). Ideally, the automation facilitates on-the-fly adjustments during drilling and grouting.

6.4.5 Materials

6.4.5.1 Grout Materials

1. Chemical admixtures are often used to improve performance of grout. See *ACI 212.3R* for use of admixtures. Air entraining admixture as a substitute for fluidifier or other admixtures should be prohibited due to potential for causing poor grout strength and/or excessive grout settlement. Required grout strength should be specified in contract documents if other than 4,000 psi (28 MPa) 28-day default strength specified in *PIP STS02465*. Commonly strength is specified as 4000 psi (28 MPa) to 5000 psi (35 MPa) based on cube testing. Note that cube strength may be somewhat higher than cylinder strength.

2. If concrete (in lieu of grout) is proposed and accepted by engineer of record, specification requirements for concrete should be provided in contract documents since concrete is not covered in *PIP STS02465*. *PIP STS03001* can be used as a reference for concrete specification requirements. Many of the requirements for concrete may be similar to grout as specified in *PIP STS02465*, although target slump for concrete should be 8 inches +/- 1 inch (200 mm +/- 25 mm) and test cylinders for concrete should be collected, prepared and tested in accordance with *ACI 301 / ACI 301M*.

3. Since adding water or admixtures on site could potentially result in decreased grout strength, advance approval of procedures and contingencies (including permissible quantities) is required by *PIP STS02465*.

4. Allowable maximum grout temperature and holding time stated in *PIP STS02465*, Section 5.5.7.6, are the same as temperatures and holding times given in *DFI TM-ACIP-4*. Opinions differ about allowable maximum grout temperature, and some think that 90°F (32°C) should be the maximum. *DFI TM-ACIP-4* warns that excessive mixing time and temperature can be detrimental to grout strength. Initial mixing time after final addition of all ingredients is typically one minute for the first cubic yard (0.75 m^3) and additional 15 seconds for each cubic yard (0.75 m^3) thereafter.

   Typically, a grout with cementitious materials of 750 lb (340 kg) of portland cement and 225 lb (102 kg) of fly ash per cubic yard (0.75 m^3) with proper combination of admixtures can have a slow heat gain that permits placement at a greater temperature. Testing is necessary to ensure desired properties are maintained. Grout suppliers sometimes change admixtures and mix design without notice.

5. Requirements in *PIP STS02465* are based on 100°F (38°C) allowable maximum temperature and 70°F (21°C) minimum delivery temperature. At 100°F (38°C), the maximum delivery time is two hours. Minimum grout temperature at placement is 40°F (4°C); mixing time for temperatures below 70°F (21°C) is two and a half hours.

6. Grout mix is assigned a mix number for identification purposes so QC inspector can verify that correct mix was delivered and placed in production piles. It is also important that the mix identification number be changed when the mix is changed – whether proportioning, cement supply, or change (addition, subtraction, or substitution) of admixtures.

7. Greater or lower grout temperatures and/or extended holding times and/or addition of water on-site may be permitted with approval of engineer of record and grout supplier. Note that in hot weather, grout is placed in a drilled hole whose temperature can be significantly less than ambient. Additional strength test cubes should be made that represent grout as-placed (typically taken from the discharge hopper). To prepare for an occurrence of low strength test results, definitions of remedial actions and assignment of responsibility for the actions should be made and agreed upon beforehand.

   Cubes are used for sand grout with a maximum size aggregate of #16 sieve (1.18 mm). Cylinders are used for concrete with larger aggregate. Ensure that equipment used is sized appropriately for grout or concrete specified.

6.4.5.2 Reinforcing Bars

Materials for reinforcing bars should be specified in contract documents.

6.4.6 Equipment

6.4.6.1 Automated Instrumentation, Monitoring and Recording

1. Purchaser and engineer should require in contract documents, the use of automated monitoring equipment instrumentation to monitor pile installation.
2. Automatic monitoring equipment typically consists of:
    a. A display and monitoring unit providing immediate feedback especially during grouting
    b. A real-time clock
    c. A depth sensor to continuously monitor auger tip depth
    d. A magnetic flow meter to measure grout flow vs. real time
    e. A rotary head pressure sensor measuring hydraulic pressure to the gearbox, useful in calculating torque
    f. A rotation sensor, measuring rotation of the auger
    g. A pressure sensor for the grout line
3. Automated instrumentation and monitoring equipment should be provided for all pile installations except those installed using limited access/low-overhead equipment due to the need to remove auger segments during grouting.

    Continuous pile installation electronic monitoring is recommended to provide good QA/QC evidence for each pile. Such monitoring will provide clear documentation of installation of the pile. Display can be arranged to provide immediate feedback to operator to adjust the installation. Many geotechnical engineers and agencies believe electronic monitoring should be required for all ACIP piles. See *DFI TM-ACIP-4*, Appendix A for more information.

6.4.6.2 Gear Box and Power Unit

1. *PIP STS02465* requires gear box to be rated to provide a minimum of 20,000 ft-lb (27,100 Nm) of torque and to apply a minimum reaction of 4,000 lb (1,800 kg) of down-force (crowd). The down-force may be either dead weight of components or mechanical force. Power unit minimum is 200 hp (150 kW). Note that these requirements, which apply to conventional ACIP piles, are minimums and need to be confirmed as adequate by constructor. Engineer may need to require equipment with greater torque and crowd for difficult soil conditions or large diameter piles.
2. Equipment must be capable of advancing the auger of specified diameter to the specified embedment within the bearing strata. Constructor should be required to demonstrate to geotechnical engineer that equipment can and has been used to install similar piles in similar conditions to those specified. This becomes

particularly important for large diameter piles and stiff or dense subgrade. It may also be critical where a small crane or drill rig is being used for deep piles; the reaction from the auger may approach the resistance of the rig, increasing risk of unexpected rig movement and damage.

3. Because encountering subsurface obstructions can cause the unit to rotate and endanger personnel, constructor should provide procedures or information on restraining the unit.

6.4.6.3 Augering Equipment

1. Augers used are continuous flight, hollow stem types with a grout injection port at bottom of the auger head below the part of the head containing the teeth. The opening should be arranged or equipped to prevent the ingress of soil or water. Some use disposable plugs.
2. Auger flighting should be continuous single-helix types without gaps or breaks. In the case of segmental augers such as those used for low headroom installations, gaps at auger joints may be up to 1 inch (25 mm).
3. Augers should have a uniform outer diameter as specified. Diameter of the inner pipe should be chosen depending on soil characteristics and type of continuous flight auger pile desired. Diameter of the inner pipe is often the constructor's decision. It may be desirable to displace some of the soil as auger passes through using the large diameter grout pipe. Soil displacement may reduce the problem of soil mining and may improve pile capacity. Direct displacement (DD) augers often use an oversize inner pipe.
4. Pitch of auger flighting is restricted to a spacing of about 9 inches (225 mm) in cohesionless soils to avoid soil mining. Cohesive soils such as clays may tolerate greater flight spacing to aid in moving the soils. Soils with mixed layers should use the tighter spacing.
5. Auger penetration rates should be steady to reduce potential for soil mining but may need to vary in mixed soil conditions. Normally penetration rates of 1.5 to 2 revolutions per flight are used in cohesionless soils and 2 to 3 revolutions per flight are used in cohesive soils. Soils with mixed layers should use higher rate of penetration (fewer revolutions) per flight. Refusal is normally defined as one ft (300 mm) per minute, but mining may occur well before this benchmark. Mining may be detectable based on increased spoil volume, formation of a cone-shaped depression at the surface, and/or – most importantly – significantly reduced pile capacity.
6. *PIP STS02465* requires marking leads for purposes of depth measurement during drilling and grouting; markings must be positioned for constant visibility by QC inspector. The QC

inspector monitors depth and rate of penetration by noting the position of the auger top or turn table relative to the markings on the mast.

7. Auger withdrawal is to be accomplished at a slow, continuous rate to maintain grout head pressure to avoid gaps or bulges in the pile.

8. *PIP STS02465* requires equipment capable of installing piles at least 10 ft (3 m) longer than that required for bid length piles; often the requirement is for 20% longer piles. It is also a good practice for constructor to provide auger sections on hand for at least 20% greater length than machine capacity; these additional sections serve as spares in case a damaged portion needs to be replaced.

9. *PIP STS02465* requires that if logs of soil borings indicate that minor obstructions may be encountered, a rock-cutting bit should be supplied and used. In highly variable soil conditions, some other type of foundation may be indicated.

6.4.6.4 Pumping Equipment

1. Positive displacement pump capable of at least 350-psi (2,400-kPa) displacement pressure at pump should be provided. Pump should be sized to assure smooth, continuous delivery of grout while limiting pressure fluctuations during auger withdrawal.

2. Pump pressure gauge should be provided in clear view of operator and readily accessible to QC inspector. Positive pressure should be maintained on grout at all times during withdrawal.

3. Pump should be calibrated on site, as described in *PIP STS02465*, prior to installation, under changed circumstances as noted or any time grout pump is suspected of not operating correctly. Pump should be capable of delivering grout volumes within 3% accuracy. A barrel test is described to facilitate computation of volume per pump stroke for manual recording. Because computed grout calibration would be low, grout should not be allowed to overflow container.

4. Constructor should position pump and leads such that QC inspector can clearly see lead marks, pressure gage, and stroke counter while standing on grout line near grout pump. QC inspector must remain close to the grout pump to count the number of grout pump strokes placed over each 5-ft (1.5-m) interval. Operator must have the same information available via monitor or direct observation.

6.4.6.5 Mixing and Transportation Equipment

1. *PIP STS02465* provides basic requirement for adequate mixing and transportation equipment to produce desired grout mix. Mixing plant may be central mix, transit mix or onsite plant.

2. Sufficient quantity of grout to complete a pile should be at the site before pile installation begins. This is for each pile in turn, not the whole day or job. Grout trucks are to be readily available at job site.

6.4.7 Execution

6.4.7.1 General

As stated above, to ensure continuous installation, sufficient quantity of grout should be at site before each pile installation begins. No open holes are permitted in ACIP pile work; otherwise, these become drilled shaft piers, which are governed by other practices. If grout is not readily available and constructor is forced to sit with the auger idle in the hole, there is an increased risk that the auger will become stuck. Rotating the auger without advancing or withdrawing while grouting is unacceptable as it leads to mining of material from the sidewalls that can result in reduced skin friction capacity of the pile.

6.4.7.2 Construction Tolerances

1. Pile centers are to be located within 3 inches (75 mm) of locations shown in contract documents. Structural engineer's pile cap (or pedestal or grade beam) design should account for pile location tolerance.
2. Vertical piles should be plumb within 2% to avoid interference with each other and to assure uniform distribution of loads to soils below. In rocky conditions, requirements are sometimes set to as much as 4%.
3. Battered piles should be installed to within 4% of pile length based on specified batter for proper load transfer and reasons stated above. Structural engineer's design should account for allowable variations in slope of vertical and battered piles.
4. Reinforcing cages or center bars should have a minimum of 3 inches (75 mm) clearance from wall of the augered hole to provide adequate grout flow and cover.
5. Finished top of pile should be no more than 1 inch (25 mm) above or 3 inches (75 mm) below elevation shown on approved working drawings.
6. Reinforcing should extend past pile cutoff as shown on drawings.

6.4.7.3 Adjacent Piles

1. *PIP STS02465* requires that piles not be placed within 6 pile diameters of each other, center to center, within 12 hours. Some other specifications vary, requiring eight pile diameters for instance, or requiring a different time interval. Generally, soils that are more granular require greater care to ensure that pile drilling does not disturb previously grouted pile.

2. Structural engineer of record and geotechnical engineers should determine allowable spacing and set time before installation of adjacent piles. This determination should consider lateral strength of soil and initial set of grout.
3. Initial grout set for ACIP piles can be field determined using a grout sample taken in a set of disposable cups made when grout truck arrives on site. Field samples should be set in shade and checked by QC inspector to determine initial set. When QC inspector inverts cup and grout comes out as a cup-shaped block only slightly plastic, the grout has achieved initial set. QC inspector should record this information on pile report.
3. If a more precise characterization of set time is desired, the mortar component of the grout may be tested in accordance with *ASTM C191*.
4. Often, constructor will install piles on an alternating pattern to provide time for grout to set. This may take creativity to devise a pattern that installs piles without affecting adjacent piles and minimizing equipment movement.

6.4.7.4 Installation Procedures

1. *PIP STS02465* provides a detailed installation procedure including contingencies for certain common difficulties in ACIP pile installation.
2. It is expected that pile parameters such as length, drilling criteria, grout factor and installation procedures of production piles will be modified by geotechnical engineer and engineer of record based on information obtained during pre-production test pile installation. This includes establishing the appropriate rates of auger penetration based on stratigraphy, auger pitch, applied crowd, and applied torque. Production piles should be installed with same equipment and identical procedures, with modifications as indicated above.
3. Oversight should be provided by an experienced QC inspector to prevent excessive rotation of the auger, which can cause loss of ground in sands particularly those classified as “running sands.” “Running sands” tend to have relatively uniform diameter with low plasticity.
4. Drilling should advance at a continuous rate appropriate for soil conditions until required depth or refusal is reached.
5. A plug should be provided in the hole at the bottom of the auger, or the line charged with compressed air, during drilling to prevent entry of soil or water into hollow stem of the auger.
6. When auger reaches specified depth, auger may be raised slightly and grout pumping should begin. When grout fills the pump line and auger tube, and the required 5 ft (1.5 m) of grout

head is developed at the auger tip, auger is re-drilled to the established tip elevation before auger withdrawal begins.

7. After grout is flowing from the auger bottom of the hollow stem, the rate of grout injection and auger withdrawal should be coordinated so that grout constantly flows from hollow stem and required volume is placed in each subsequent depth increment.
8. Grout head pressure of 5 ft (1.5 m) should be continuously maintained above injection point during withdrawal of auger. When grout first appears at grade, auger depth is known as "grout return depth". Above this point, it is generally not possible to maintain grout head pressure; grout pumping and auger withdrawal should continue at the same steady rate.
9. Minimum theoretical grout volume (115%) as specified in *PIP STS02465* should be increased as necessary in accordance with volume used in test piles and/or recommendations of geotechnical engineer, based on soil type encountered during soil borings.
10. Spoil that accumulates around auger during drilling and injection of the grout should be cleared promptly, because the reinforcing installation and cut-off need to be established. Cylinders can be used to adjust the cut-off elevation slightly below or above existing grade.
11. Reinforcing steel should be placed as soon as possible and while grout is still fluid (prior to initial set). Reinforcing should sink by its own weight or require only minor assistance in installation. When reinforcing cage is installed easily, there is a good chance that the pile is free of severe constrictions.

    a. Constructor should stiffen reinforcing cages for handling by tying all bar intersections tightly with wire. Bracing across the center of the cage should be avoided as it greatly increases penetration resistance.

    b. In hot weather, cages or bars should be sprayed with water just before insertion to cool reinforcing. This improves the bar to grout bond.

    c. Tops of piles should be carefully screened to fresh concrete before reinforcing is placed, as part of keeping bars clean for optimum concrete bond.

    d. Reinforcing steel should not be forced into the grout filled pile shaft using a backhoe or other mechanical equipment though slight mechanical assistance is acceptable. Pile Installation Records should note whether reinforcing steel was placed into the pile smoothly without encountering any obstructions.

    e. Separate crane to handle and install long reinforcing cages should be considered. A crane can improve cage

installation, reduce damage to the cage, reduce contamination of cage due to mud, and release drilling rig to continue work. Typically, few problems are experienced if cages are placed within 10 to 15 minutes of grout placement and pile top screening.

12. Drilling of nearby piles can cause settlement/subsidence of grout in previously completed piles. QC inspector and constructor should observe the tops of completed piles to note any grout subsidence for the period before initial set occurs.
13. Grout subsidence of about one ft (0.3 m) can generally be handled by topping off piles with additional grout if pile grout has not achieved initial set.
14. In case of greater grout subsidence, increase minimum pile spacing, alternate pile locations, and/or allow grout to set for a longer time. Adjacent piles can be placed after initial set occurs, but note that *PIP STS02465* requires that 12 hours elapse.

6.4.7.5 Spoils Handling

1. The drilling process produces spoils in the form of excess grout and soil returned to surface by the augers.
2. Contract documents should clearly state which party is responsible for removing and disposing spoils, any restrictions on disposal, and location of a disposal area provided, if any.

   Comment: On some projects, general construction constructor may be responsible for removing spoils. This makes pile installation sequence more difficult to complete in an orderly sequence. Special efforts are required to coordinate the work between the general construction constructor and piling constructor.

3. If soil is contaminated, handling and disposal costs should be considered in determining the feasibility of ACIP pile system.
4. If contaminated spoil disposal is an issue, but drilled piles are preferred over driven piles, drilled displacement (DD) piles may be considered because of reduced or eliminated spoils. All types of DD piles do not necessarily eliminate spoils, but may significantly reduce amount of spoils. Various types of proprietary DD piles may be more or less suited for different soil conditions. Appropriate engineering, including geotechnical engineering, should be performed if considering DD piles.

6.4.7.6 Obstructions

1. If an obstruction is encountered and it does not allow pile to be completed in the planned location, constructor should notify geotechnical engineer and engineer of record in order for these parties to determine remedial action.

2. Geotechnical engineer will determine if pile is acceptable as installed or if remedial measures are required.

3. Normally, the most cost effective and time saving remedial measure is to re-drill and re-grout the pile if suspect conditions are observed.

6.4.7.7 Termination (Pile Cut-Off)

1. Constructor should cut off the tops of piles and square with pile axis at elevations indicated on the approved working drawings, by removing fresh grout or concrete from top of the pile or by cutting off hardened grout or concrete down to final cutoff point at any time after initial set has occurred.

2. Reinforcing should extend specified amount above the pile cut off elevation in order that reinforcing can be developed in pile cap. Often the cage must be temporarily supported in the fluid grout column to maintain the design elevation.

6.4.7.8 Low-Overhead ACIP Piles

1. Low headroom working conditions are best avoided. If it is necessary to use low headroom construction, use smaller piles [usually 18-inch (450-mm) diameter or less] and smaller working loads per pile to avoid installation problems with small lightweight rigs.

2. Low headroom equipment can be used effectively with ACIP piles and is often more cost effective than high strength micro-piles if ground conditions are favorable for ACIP pile installation.

3. Note that continuous placement of grout is not possible when the auger string must be broken during withdrawal. Therefore, this technique should only be used in favorable ground conditions and with close control to maintain grout pressure and volume during extraction.

4. Low headroom ACIP pile rigs avoid using a crane mast and utilize segmental auger sections to achieve the low headroom capability. Torque capacity and crowd for such rigs are limited to about 21,000 ft-lbs (28 kN-m) and 3,000 lbs (13 kN), respectively. Because of these limitations, low headroom equipment should only be used in the most favorable soil conditions for which minimal risk of soil mining exists. Based on engineering judgment, the minimum rig capacity specified in *PIP STS02465* may be relaxed for light duty, low-headroom projects.

5. Spliced steel cages and/or coupled threaded bars are often necessary to install reinforcement in low headroom applications.

6. Low-headroom installation is slower to the extent auger sections must be spliced. Auger sections should be keyed to minimize the hazards of unscrewing sections. Use of pipe wrenches is

discouraged to potential breakage and incurring personnel injury or damage to equipment in tight conditions normally encountered in low-head room situations.

6.4.7.9 Drilled Displacement Piles

Drilled displacement (DD) pile applications are discussed in Section 4 above. While DD piles are a type of ACIP pile, normally DD pile installation involves proprietary equipment, especially auger configuration. *PIP STS02465* provides minimum equipment size only, requiring constructor to demonstrate adequacy and applicability of system. Apart from equipment, other QA/QC requirements apply.

6.4.7.10 Probe, Reaction and Test Piles

PIP STS02465 defines functions of probe, reaction and test piles as part of pre-production program. These can be most useful in defining capacity of piles, proving adequacy of proposed equipment, and refining soil stratigraphy across project site. Such a program is highly recommended; actual extent must be defined elsewhere in contract documents.

6.5 Specification Inspection, Testing and Acceptance

6.5.1 Inspection

6.5.1.1 Inspection data requirements for ACIP piles during installation differ from the data typically obtained for driven piles or drilled shafts. Problems that are difficult to detect can occur, which can reduce the load carrying capacity of an ACIP pile. For this reason, careful, full-time, purchaser-retained on-site inspection by an experienced professional is considered essential; refer to the definition of the QA representative. Modifications should be made to inspection requirements to fit specific needs of each project.

6.5.1.2 Automated instrumentation and monitoring systems, as described elsewhere in this document, should be provided to enhance the inspection. This type of system should be used wherever feasible. Even if instrumentation is provided by the constructor, a qualified QC inspector should be present during ACIP pile work. The special instrumentation cannot typically be used for ACIP piles installed in areas having restricted headroom conditions, because low headroom ACIP piles have the auger installed and removed in segments. Grout pressure is released each time an auger section is removed.

6.5.1.3 For additional information on inspection criteria, installation procedures, inspection tools, common problems and the responsibilities of the parties for successful installation of these ACIP piles, see *DFI TM-ACIP-2* and, *Inspection and Quality Control of Augercast Piles* by Piscsalko and White.

6.5.2 Integrity Verification

6.5.2.1 ACIP pile integrity testing is performed to assure there are no major defects in the ACIP piles. Type and frequency of tests should be defined in contract documents. The engineer normally specifies a number or percentage of production piles to be integrity tested, with an increase or

decrease in frequency based on results. Often 10 to 20 ACIP piles are tested to start the project and 10 to 20 more for every 200 ACIP piles. In some cases, purchaser may require 100% of piles to be tested with low strain pulse echo (LSPE); at the other extreme it may be required only where some aspect of installation was deemed to be questionable.

6.5.2.2 LSPE testing (in accordance with *ASTM D5882*) is the quickest and least expensive test method. It is basically a sonic echo test made with a hammer on the hardened pile surface (pile top is ground smooth). It is performed at least three to seven days after installation. It is generally limited to length-to-diameter ratio of 30 or less. It is less sensitive than other methods, detecting only major defects and often only the shallowest defect (if any is found). It cannot differentiate between a hairline crack and a large void.

6.5.2.3 Single-hole sonic logging (SSL) and cross-hole sonic logging (CSL) testing (in accordance with *ASTM D6760*) requires down-hole instrumentation in water-filled tubes installed into the wet grout (one or two tubes respectively). The tests are performed one to two days after pile installation. After three days, the pipe may de-bond and render the tests ineffective. (PVC pipe is commonly used but steel pipe has been shown to be better for bonding). These methods are more accurate but more expensive and time-consuming. Cross-hole sonic logging is suitable for larger piles; generally limited for cost reasons to piles with high bending moments and/or 30 inch (750) mm diameter and larger.

6.5.2.4 Thermal Integrity Profiling (in accordance with *ASTM D7949*) is another method that can be used. With this method, heat generated by curing cement is measured along the full length of the ACIP pile. This data is used to evaluate the grout/concrete quality of the entire cross-section, including outside the reinforcing cage along the full length of the pile, without maximum length limitations. Thermal Integrity Profiling is typically completed within 48 hours of installing the ACIP pile which can provide integrity evaluation earlier than some other methods. If this method is used, requirements for the ACIP pile constructor will need to be included in the contract documents.

6.5.2.5 Refer to *DFI TM-ACIP-3* for Guideline for Interpretation of Nondestructive Integrity Testing of Augered Cast-in-Place and Drilled Displacement Piles.

6.5.3 Load Testing

6.5.3.1 Timing

1. Pile capacity verification may be performed on test ACIP piles at three different times depending on objectives:
    a. Before production installation begins, to determine if ACIP pile length or number can or should be modified to carry intended loads;
    b. As production installation begins, to determine if chosen ACIP pile installation method is developing adequate

strength and to allow modification of length and number of ACIP piles;

c. During and after production installation, to determine if ACIP piles are developing design strength. Normally load testing is carried out on a relatively small number of piles.

2. Capacity verification requires constructing test piles using equipment, methods and materials identical to production installation.

3. For pre-production testing, to assure validity, capacity verification should be performed on the portion of site where soils are expected to be weakest based on soil borings or CPT testing.

4. For early production testing, test piles should be among the first ten piles installed, to prove method of constructing and load capacity.

5. Tests should be conducted at least seven days after installation. Waiting for a longer period will allow grout to achieve greater strength.

6.5.3.2 Test Piles

1. Location, length, number, etc., of probe and/or test piles should be shown in contract documents.

2. Type of load tests (i.e., compression, tension, and lateral) should be specified in contract documents. Where two or more tests are to be performed on a pile, the sequence should be compression, tension, lateral.

3. If tension or lateral testing is required, the type of test loading procedure should be specified in contract documents.

4. Test pile(s) should be installed adjacent to an existing (or additional) soil boring or cone penetrometer (CPT) location such that soil conditions at test location are well defined. Test pile locations should be selected at locations where soil conditions are expected to be relatively weaker compared with rest of project site. Engineer can conclude that production piles at other locations will perform as well or better than the test pile.

5. Details of telltales or strain gauges for test piles should be provided. Telltale information can assist in resolving questions about structural integrity during load test and help estimate the side friction and end bearing capacity.

Comment: Telltale can easily be installed by tying a closed end small diameter casing of PVC or other material to the center reinforcing bar. After grout sets and prior to testing, a steel bar (rebar) is inserted, mounted with a dial deflection gauge and referenced to an independent reference beam to obtain pile tip deflections.

6. Test piles and reaction piles should be equipped with telltales and/or strain gauges to record pile movement at both top of pile and near pile tip.
7. Telltale data should be used to evaluate side soil friction support and end-bearing support, in addition to providing a confirmation that pile shaft was not damaged during testing. This is important for cast-in-place piles, which are typically tested before grout reaches full strength.
8. If test piles and reaction piles are equipped for telltales, PVC pipe should be large enough to permit sonic logging along length of piles to check pile integrity.
9. If approved by geotechnical engineer and engineer of record, test piles and reaction piles may be permitted to be incorporated as load bearing components of a foundation. If incorporation in foundation is permitted, a minimum of four reaction piles per test pile should be used.
10. In some cases, neither test piles nor reaction piles become a part of the permanent foundation system. However, if a pile integrity test indicates a pile is still sound after testing, that pile can be permitted to be part of a foundation.

6.5.3.3 Pile Load Testing

1. Capacity verification must be based on static load (compression) tests by *ASTM D1143/D1143M* as the standard. If different from *PIP STS02465*, type of test load procedure should be specified. Dynamic load tests must be calibrated to results of the static load test.
2. Constructor should design the test frame and select test equipment subject to the approval of geotechnical engineer and engineer of record.
3. Commonly in the US, the Davisson Offset Limit (DOL) is used as a criterion for determining failure for load test purposes. Failure using this method is defined as [elastic shortening of the pile] + [0.15 inch (3.8 mm)] + [pile diameter/120]. However, this criterion is now considered overly conservative for cast-in-place piles; there is some indication that the third term may be multiplied by a factor of 4 to estimate the true ultimate capacity. There are several possible alternative criteria (e.g., Brinch Hanson 90% Criterion, Butler-Hoy Criterion); geotechnical engineer should specify test method details and interpretation.
4. The “Quick” load test method should be used but the load hold times should be increased to ten minutes to permit sufficient time to take all readings and permit a safety inspection of test pile top and reaction pile connections before increasing test loads.
5. Dynamic Load Testing (DLT) in accordance with *ASTM D4945* is a method to assess a pile’s bearing capacity by applying (a dropping mass) to a pile head. DLT can offer advantages of

speed and economy, compared to conventional static testing, where it has been calibrated to local soil conditions. On a larger project, it may be worth considering a single control static test supplemented with a large number of DLTs. If dynamic load testing is required, a written procedure for dynamic load testing should be provided in contract documents. The following should be considered in choosing to permit dynamic load testing and accounted for in selecting pile design capacities:

a. Viability of the testing

b. Applicability to a specific pile application

c. Assurance that testing cannot harm the structural integrity of the pile

d. Justified degree of confidence that can be assigned to the results

6.5.3.4 Rejected Piles

Engineer of record in consultation with geotechnical engineer will need to determine if any ACIP piles will be required to be removed and replaced at constructor's expense, or other remedy required, in the circumstances listed in *PIP STS02465*.

7. Payment Guidelines

7.1 Basis of Payment

7.1.1 Basis for payment for pile installation should be specified in contract documents.

7.1.2 Typically, purchaser should request lump sum bids for entire installation of piles and unit pricing for over and under the bid quantity of piles.

7.1.3 Grout quantities in excess of 115% of the theoretical grout volume should be carefully documented by QA representative to permit verification of the volumes reported on the constructor's installation record.

7.1.4 Unit pricing for changes before production commences (e.g., from test pile program results) is appropriate.

7.1.5 Constructors may limit the range for changes in pile length or diameter because of resulting requirements for larger equipment, which the lump sum bid and unit prices did not anticipate.

7.1.6 Payment for pile load tests should be based on furnishing and installing sufficient reaction materials including beams and jack to apply a minimum of three times the design load for the pile. Payment for use of equipment limiting the test to a lesser load should be reduced proportionately. Where more than one test is required, terms should address standby of test equipment between uses as well as delays to the work while waiting for arrival of test equipment.

7.1.7 Payment for pile integrity tests should include materials, equipment, personnel, field interpretation, and final report in hard copy, raw data, and electronic data file which can be analyzed by the engineer of record and geotechnical engineer.

7.2 Obstructions and Payment for Obstructed Piles

7.2.1 Equity and administrative law make underground obstructions an owner responsibility. Obstructions can cause constructor to incur downtime, potential equipment damage, and possible loss of grout.

7.2.2 Even with a rock bit, ACIP pile rigs cannot penetrate a significant distance into hard rock, and rock bits may not penetrate many obstructions. Extended drilling time at reduced penetration increases the risk of mining and may not produce an acceptable pile even if the target depth is eventually obtained.

7.2.3 Requirements should be provided in contract documents for handling piling installation obstructions if encountered.

7.2.4 Payment calculation method for piles terminated due to obstruction should be provided in contract documents.

7.2.5 If non-augerable material is encountered above the required tip elevation, pile should be grouted and completed. The intent is to backfill hole with grout, so side walls of hole do not slough in and adversely affect nearby piles. Engineer of record should be notified to determine if pile is acceptable as installed or if remedial measures are required.

Appendix G.R.7

Shear Wave Velocity Report

GEOLINES

July 29, 2020

Souder, Miller & Associates
3500 Sedona Hills Parkway
Las Cruces, New Mexico 88011

Attention: Ms. Sarah Garduno, E.I.T.

RE: **Shear Wave Velocity Profile**

NMSU Bio Med Building
New Mexico State University
Las Cruces, New Mexico
Geolines Project No. NM-200032
SMA Project No. 9329475

Dear Ms. Garduno:

This letter report presents the results of our refraction microtremor measurements and analysis for the referenced project. The purpose of our services was to provide a calculated average shear wave velocity of subsurface materials at the NMSU Bio Med site to a depth of 30 meters (100 feet). This information was used to establish a recommended Site Class in accordance with the 2015 International Building Code (IBC).

Fieldwork

The scope of our services for this project included measurement of surface waves on July 16, 2020, with one geophone array using standard p-wave geophones. Ambient noise/refraction microtremor data was recorded using a geophone spacing of eight meters with 12 channels. Sampling was performed at a two-millisecond rate for 30 second periods.

The approximate location of the array is shown on Plate 1, Site Map. The array was located in the field by measuring from existing natural and cultural features. The location of the array is accurate only to the degree implied by the methods used.

Data reduction and results

The one-dimensional shear wave velocity profile and average shear wave velocity to 100 feet depth were modeled for each array data set using Optim Software's SeisOpt® ReMi™v4.0 software. The field data were reduced and processed by the software to produce a velocity spectrum by slowness-frequency (p-f) transformation of the records.

Using the processed data, the software produces a p-f image and the normal-mode dispersion trend is identified. Frequency-velocity pairs comprising the dispersion curve are picked at the

lower bounds of the trend of the high spectral ratio band identified in the p-f image. The p-f image and dispersion modeling picks for the array measurements are shown on Plate 2, Dispersion Curve and p-f Image. The dispersion curve modeling picks obtained from the p-f image were then used to develop a calculated dispersion curve and a one-dimensional shear wave velocity model for the site. Frequency-velocity picks and calculated dispersion curve fits are shown on Plate 2, Dispersion Curve and p-f Image. The shear wave velocity profile for the array is presented in Plate 3, Shear Wave Velocity Model.

Recommendations

The calculated average shear wave velocity for 100 feet depth at the geophone array is 1217 feet per second (f/s). Based on this finding, a Site Class C as presented in the 2015 IBC is appropriate.

Closure

Professional services for this project were performed using that degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical engineers practicing in this or similar localities. No warranties, express or implied, are intended or made.

Respectfully Submitted:

Zachary J. Rockhold
Project Manager

Reviewed By:

Otto C. Holmquist, PE
Principal Engineer

OTTO C. HOLMQUIST
NEW MEXICO
13286
PROFESSIONAL ENGINEER

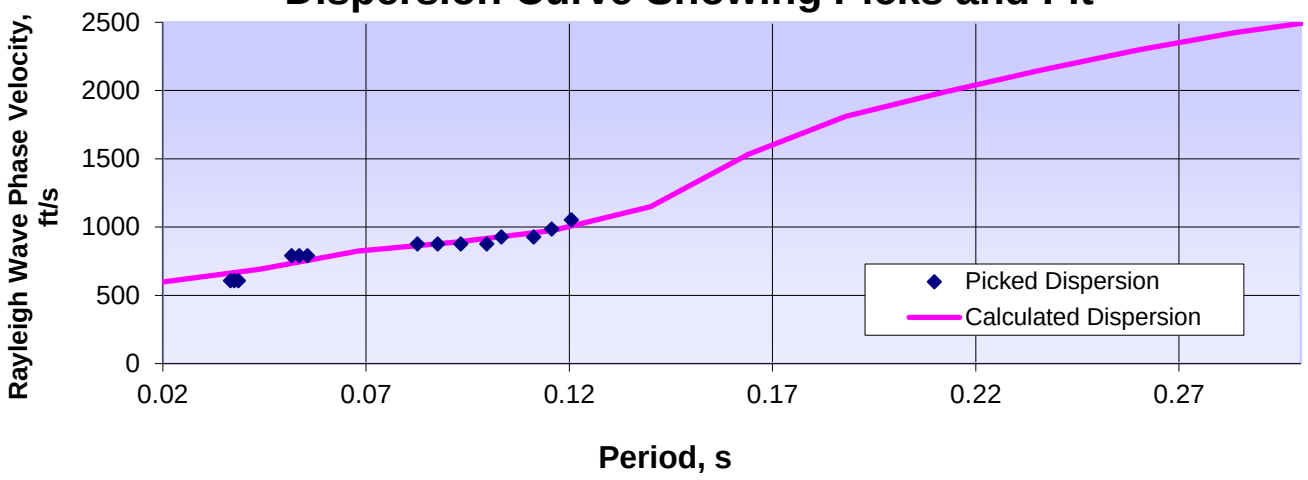
7/20/2020

*Not to Scale

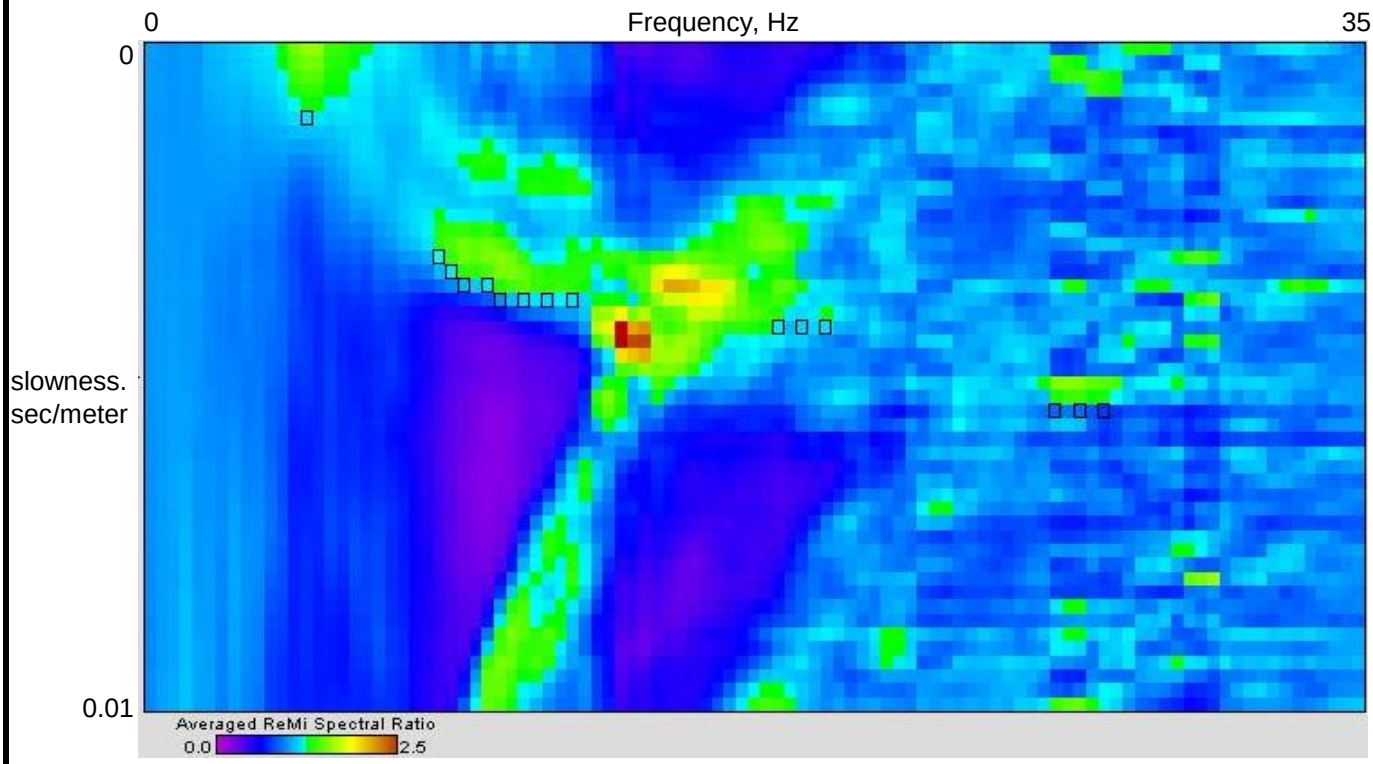
North

GEOLINES SMA Project No: 9329475	**Souder, Miller & Associates**	**SITE MAP**
	NMSU's Bio Med Building Location Las Cruces, New Mexico	PROJECT NO.: NM-200032 PLATE NO. 1

Dispersion Curve Showing Picks and Fit

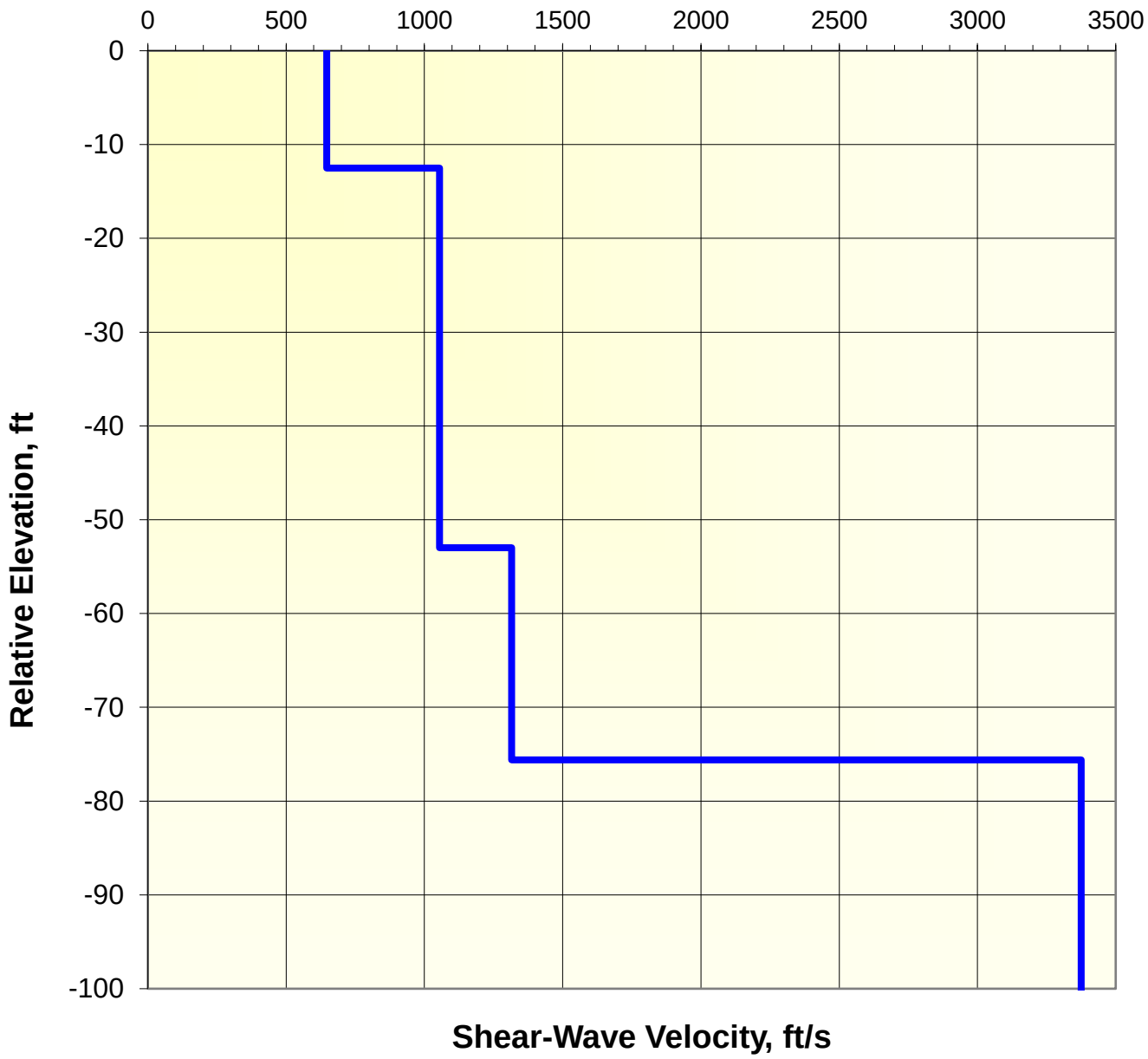


p-f Image and Dispersion Picks



GEOLINES SMA Project No: 9329475	**Souder, Miller & Associates**	**Dispersion Curve and p-f Image**	
	NMSU's Bio Med Building Location Las Cruces, New Mexico	PROJECT NO.:	PLATE NO.
		NM-200032	2

1-D Shear-Wave Velocity Profile



* The modeling methods used to calculate shear wave velocities do not necessarily have unique solutions, therefore velocities and depth to changes in velocities should be considered approximate.

GEOLINES SMA Project No: 9329475	**Souder, Miller & Associates** NMSU's Bio Med Building Location Las Cruces, New Mexico	**SHEAR WAVE VELOCITY MODEL** PROJECT NO.: NM-200032 PLATE NO. 3

004325 – SUBSTITUTION REQUEST FORM – DURING PROCUREMENT

SEE AGGIE MART FOR FORM

006325 – SUBSTITUTION REQUEST FORM – DURING CONSTRUCTION

SEE AGGIE MART FOR FORM

007200 - WAGE RATES

Davis Bacon Rates apply to this project

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Work covered by the Contract Documents.
2. Type of the Contract.
3. Work phases.
4. Work under other contracts.
5. Products ordered in advance.
6. Owner-furnished products.
7. Use of premises.
8. Owner's occupancy requirements.
9. Work restrictions.
10. Specification formats and conventions.

B. Related Sections include the following:

1. Division 1 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: NMSU Agricultural Modernization: Biomedical Research Building

B. Owner: New Mexico State University

1. Owner's Representatives: Ashley Burkholder,

(505) 948-0756

C. Architect: Fanning Bard Tatum Architects Ltd, 6501 Americas Pkwy NE, Suite 300, Albuquerque, NM 87110

1. Principal Architect: Susan Johnson (505) 883-5200

D. The Work consists of the following:

This project manual represents work for the NMSU Biomedical building EXPANSION.

The Building Expansion in this project is an "extension" of the existing "Phase 1 & 2" biomedical research building already located on the same site. The work represented in these project documents includes but is not limited to: select demolition of work done in Phase 2, site utilities and improvements, steel structure, building envelope, mechanical, electrical, technology, and plumbing systems, landscaping, interior wall framing, interior fixtures, furnishings and equipment, interior finishes, casework, doors and windows. The project will include a building expansion joint and extension of utilities from the Phase 1 & 2 building. This project is designed according to NIH requirements and includes a LEED component as well. Once completed, the building expansion along with the Phase 1 & 2 building will become 1 complete biomedical laboratory facility for the NMSU campus, approximately 10,000 Gross Square Feet in total. Currently there is a portion of the north end of the existing Neale Hall building and site that will be demolished and repaired in preparation for the Building Expansion work in this project, however the Neale Hall demolition is considered a separate project.

1.4 TYPE OF CONTRACT

A. Project will be constructed utilizing The New Mexico State University agreement forms and associated general plus supplementary conditions included in the Project manual.

1.5 WORK PHASES

A. The Work shall be conducted in one phase.

B. Before commencing Work, Contractor to submit a schedule showing the sequence, commencement, completion dates and move-in dates of Owner's personnel of the Work. Note this contract includes Contractor Furnished Contractor Installed equipment which must be installed prior to substantial completion will be issued.

1.6 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contract.

1.7 OWNER-FURNISHED PRODUCTS

A. Owner will furnish products indicated. The Work includes providing support systems to receive Owner's equipment and making plumbing, mechanical, and electrical connections.

1. Owner will arrange for and deliver Shop Drawings, Product Data, and Samples to Contractor.

2. Owner will arrange and pay for delivery of Owner-furnished items according to Contractor's Construction Schedule.
3. After delivery, Owner will inspect delivered items for damage. Contractor shall be present for and assist in Owner's inspection.
4. If Owner-furnished items are damaged, defective, or missing, Owner will arrange for replacement.
5. Owner will arrange for manufacturer's field services and for delivery of manufacturer's warranties to Contractor, if required.
6. Contractor is responsible for protecting Owner-furnished items from damage during storage and handling, including damage from exposure to the elements.
7. If Owner-furnished items are damaged as a result of Contractor's operations, Contractor shall repair or replace them.
8. Contractor shall install and otherwise incorporate Owner-furnished items into the Work.

B. Owner Furnished/Owner Installed Products:
1. Security system and cameras
2. Access control card readers
3. Furniture
4. Appliances
5. Equipment (as scheduled)

1.8 USE OF PREMISES

A. General: Contractor shall have full use of existing facility during construction.

1.9 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.

2. Absolutely no equipment to cross the existing utility tunnel located north of the building under the south sidewalk along Frenger.

B. On-Site Work Hours: Normal business working hours, Monday through Friday, except as otherwise indicated.

1. Weekend Hours: As required. Notify NMSU in advance of weekend work hours.

2. Early Morning Hours: As required. Notify NMSU in advance of early work hours.
3. Hours for Utility Shutdowns: Notify NMSU ten days in advance of scheduled shutdowns.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Architect and Owner not less than ten days in advance of proposed utility interruptions.
2. Obtain Owners written permission before proceeding with utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy within adjacent buildings or public ways with Owner.

1. Notify Architect and Owner not less than two days in advance of proposed disruptive operations.
2. Obtain Architect's and Owner's written permission before proceeding with disruptive operations.

E. Nonsmoking Campus: Smoking is not permitted on NMSU Property except within designated areas.

F. Controlled Substances: Use of tobacco products and other controlled substances is not permitted.

G. Employee Identification: Provide identification tags for Contractor personnel working on the Project site. Require personnel to utilize identification tags at all times.

H. Employee Screening: Comply with Owner's requirements regarding drug and background screening of Contractor personnel working on the Project site.
1. Maintain list of approved screened personnel with Owner's Representative

1.10 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the Masterformat 2004 edition and CSI/CSC's "MasterFormat" numbering system.

1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
2. Division 1: Sections in Division 1 govern the execution of the Work of all Sections in the Specifications.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred, as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor.

Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012300 – ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. ALTERNATE A: FINISHES

BASE BID:

1. Epoxy paint at restroom walls
2. Paint at drinking fountain wall and epoxy paint at wing walls
3. FRP at emergency shower walls
4. Sealed concrete floor at Insectary and Aviary Exterior Anterooms
5. Sealed concrete floor at entry main door C700
6. No paint at exposed ductwork and grilles in rooms with no ceilings (i.e., open to structure)
7. Epoxy paint at Janitor walls
8. Crash railing installed at:
    a. H105 Corridor
    b. 154 Anteroom 3
    c. 165 Animal Holding Suite
    d. 165F Anteroom
    e. 171 Anteroom 300
    f. 173 Insectary Suite
    g. 177 Anteroom
    h. 179 Aviary Suite

ADDITIVE ALTERNATE:

1. Wall tile at restroom at walls
2. Wall tile at drinking fountains / epoxy paint at wing walls
3. Wall tile at emergency showers – all sides
4. Walk – Off carpet tile at Insectary and Aviary Exterior Anterooms (4’x6’)
5. Walk – Off carpet tile at main entry door C700 (4’x6’)
6. Paint exposed ductwork and grilles in rooms with no ceiling (i.e., open to structure)
7. FRP at Janitor walls
8. Crash railing installed at all rooms noted in Base Bid Finishes and the following:
    a. 154D Food & Bedding
    b. 156 Clean Cage Storage
    c. 158 Food Prep
    d. 154A Quarantine / Procedure 1
    e. 154B Quarantine / Procedure 2
    f. 154C General Storage
    g. 165C Wild Animal Housing 1
    h. 165B Wild Animal Housing 2
    i. 165A Wild Animal Housing 5
    j. 165D Wild Animal Housing 3
    k. 165D Wild Animal Housing 4
    l. 167 Microscopy
    m. 173BB Anthropod Chamber Rearing Room 3
    n. 173AA Anthropod Chamber Rearing Room 4
    o. 173B Prep Anteroom 3
    p. 173A Prep Anteroom 4
    q. 173D Prep Anteroom 1
    r. 173C Prep Anteroom 2

s. 179F Bird Rm A
t. 179E Bird Rm B
u. 179D Bird Rm C
v. 179C Bat Rm A
w. 179B Bat Rm B
x. 179A Bat Rm C
y. 179 Procedure
z. 179H Storage
aa. 179I Aviary Food Prep
bb. 174 Insectary Equip Stg
cc. 172 Procedure / Behavioral 3
dd. 170 Procedure / Behavioral 2
ee. 168 Procedure / Behavioral 1

B. ALTERNATE B: CASEWORK

BASE BID:

1. No upper / lower casework in Work Area 161A or Break Rm 161
2. Wall mounted sink in Break Rm 161
3. No upper or lower casework in “Flex Room” area
4. No lockers or change bench in Gender Neutral Shower

ADDITIVE ALTERNATE:

1. Upper and lower casework in Work Area 161A and Break Rm 161
2. In-counter sink installed in Break Rm 161
3. Upper and lower casework in “Flex Room”
4. Lockers and change bench in Gender Neutral Shower

C. ALTERNATE C: ROOF

BASE BID:

1. Fabric-Reinforced Thermoplastic Polyolefin Sheet (TPO)
   a. 60 mils, nominal
   b. Exposed Face Color: White
   c. Substrate Board: glass-mat, water resistant gypsum substrate, 1/2” thick

ADDITIVE ALTERNATE:

2. Fabric-Reinforced Thermoplastic Polyolefin Sheet (TPO)
   a. 80 mils, nominal
   b. Exposed Face Color: White
   c. Substrate Board: glass-mat, water resistant gypsum substrate, 5/8” thick

D. ALTERNATE D: SITE

BASE BID:

1. Basecourse drive @ 147,323 S.F.

ADDITIVE ALTERNATE:

2. Asphalt pavement drive and pavement markings @ 147,323 SF
3. Loading dock lift and concrete pad @ 102 SF
   a. power and all associated components for a fully functional lift system

END OF SECTION 012300

PAYMENT PROCEDURES
SECTION 01 2900

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Sections include the following:

1. Division 1 Section "Allowances" for procedural requirements governing handling and processing of allowances.
2. Division 1 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
3. Division 1 Section "Unit Prices" for administrative requirements governing use of unit prices.
4. Division 1 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:

a. Application for Payment forms with Continuation Sheets.
b. Submittals Schedule.
c. Contractor's Construction Schedule.

2. Submit the Schedule of Values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:

    a. Project name and location.
    b. Name of Architect.
    c. Architect's project number.
    d. Contractor's name and address.
    e. Date of submittal.

2. Submit draft of AIA Document G703 Continuation Sheets.
3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

    a. Related Specification Section or Division.
    b. Description of the Work.
    c. Name of subcontractor.
    d. Name of manufacturer or fabricator.
    e. Name of supplier.
    f. Change Orders (numbers) that affect value.
    g. Dollar value.

        1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate. Include separate line items under required principal subcontracts for operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training in the amount of 5 percent of the Contract Sum.
5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing.

7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
9. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.

10. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.

1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Times: Progress payments shall be submitted to Architect by the 15th of the month. The period covered by each Application for Payment is one month, ending on the last day of the month 15 days prior to the date of each progress payment.

D. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.

E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

F. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.

1. Submit partial waivers on each item for amount requested in previous application on each item.
2. When an application shows completion of an item, submit final or full waivers.

3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of Values.
3. Contractor's Construction Schedule (preliminary if not final).
4. Products list.
5. Schedule of unit prices.
6. Submittals Schedule (preliminary if not final).
7. List of Contractor's staff assignments.
8. List of Contractor's principal consultants.
9. Copies of building permits.
10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
11. Initial progress report.
12. Report of preconstruction conference.
13. Certificates of insurance and insurance policies.
14. Performance and payment bonds.
15. Data needed to acquire Owner's insurance.
16. Initial settlement survey and damage report if required.

J. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

K. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.

9. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 2900

SUBMITTALS
SECTION 01 3000

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Submittal procedures.

B. Construction progress schedules.

C. Shop Drawings.

D. Product data.

E. Samples.

F. Manufacturers' instructions.

G. Manufacturers' certificates.

1.02 RELATED SECTIONS

A. Section 01600 – Products and Substitutions.

B. Section 01700 - Contract Closeout.

1.03 SUBMITTAL PROCEDURES

A. Transmit each submittal with accepted form.

B. Sequentially number the transmittal forms. Re-submittals to have original number with an alphabetical suffix.

C. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.

D. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

E. Schedule submittals to expedite the Project, and deliver to Architect/Engineer at business address. Coordinate submission of related items.

F. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

G. Provide space for Contractor and Architect/Engineer review stamps.

H. Revise and resubmit submittals as required, identify all changes made since previous submittal.

I. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

J. Make submittals for products which require color selection for interior or exterior materials for coordination of color selections.

1.04 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule (Microsoft Project 98 format) in duplicate within 10 days after date of permit for major portions of the work.

B. Revise and resubmit as required.

C. Submit revised schedules with each Application for Payment, identifying changes since previous version.

D. Submit a horizontal bar chart with separate line for each major section of Work or operation, identifying first work day of each week.

E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

F. Indicate estimated percentage of completion for each item of Work at each submission.

G. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates, including those furnished by Owner and under Allowances.

1.05 SHOP DRAWINGS

A. Submit pdf fill format submittals for review by the Architect and Owner. Include a tracking cover sheet including submittal name, number, date submitted. Submittals are to be reviewed by the General Contractor prior to forwarding to Architect for conformance with the contract documents.

B. “Checking” of shop drawings shall be regarded as gratuitous assistance to Contractors. Review status by Architect shall refer only to conformance with the design intent, and will in no way relieve the Contractor of his responsibility for the correctness of measurements and the alignment of the work nor from the necessity of furnishing material and work required by the contract documents.

C. The Architect assumes no responsibility for errors or omissions on shop drawings and should such be discovered later, all subsequent work, materials, etc., shall be furnished and installed for a complete and proper installation and at the Contractor’s expense.

D. Contractor will review Shop Drawings, Product Data and Samples prior to submission. Determine and verify: Field measurements, field construction criteria, catalog numbers and similar data and conformance with specifications. Failure to do so will cause return of submittal without consideration. Contractor shall be liable for any delays or other costs caused by inaccurate or inadequate submittals. Submittals will be reviewed by Architect to verify that Contractor is making the dimension drawings required for his construction layout. Approval of these submittals by Architect does not relieve Contractor of compliance with Contract Documents. Submittals will be returned without consideration if Contractors approval stamp is not affixed and signed, or if it is obvious that the Contractor has not reviewed the submittal.

E. After review, reproduce and distribute in accordance with Article on Procedures above and for Record Documents described in Section 01700 - Contract Closeout.

1.06 PRODUCT DATA

A. Submit the number of hard copies which the Contractor requires, plus three (3) hard copies which will be retained by the Architect and the Owner.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.

C. After review, reproduce and distribute in accordance with Article on Procedures above and for Record Documents described in Section 01700 - Contract Closeout.

1.07 SAMPLES

A. Verify list of products which require sample submittals with architect prior to submittals.
   1. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
   2. Submit samples of finishes from the full range of manufacturers' standard colors or in custom colors indicated, textures, and patterns for Architect's selection.
   3. Include identification on each sample, with full Project information.
   4. Submit the number or samples specified in individual specification Sections; one of which will be retained by Architect.
   5. Reviewed samples which may be used in the Work are indicated in individual specification Sections.

1.08 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification Sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.09 MANUFACTURER'S CERTIFICATES

A. When specified in individual specification Sections, submit manufacturers' certificate to Architect for review, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect/Engineer.

PART 2 - PRODUCTS - Not Applicable To This Section

PART 3 - EXECUTION - Not Applicable To This Section

END OF SECTION 01 3000

PROJECT MANAGEMENT AND COORDINATION
SECTION 01 3100

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. Coordination drawings.
2. Administrative and supervisory personnel.
3. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.

C. Related Sections include the following:
1. Division 1 Section "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule.
2. Division 1 Section "Execution Requirements" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Division 1 Section "Closeout Procedures" for coordinating Contract closeout.

1.3 COORDINATION

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Pre-installation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.
9. Project closeout activities.

E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
b. Indicate required installation sequences.
c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

d. PDF Format

2. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1. Include special personnel required for coordination of operations with other contractors.

1.6 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

a. Tentative construction schedule.
b. Phasing.
c. Critical work sequencing and long-lead items.
d. Designation of key personnel and their duties.

e. Procedures for processing field decisions and Change Orders.
f. Procedures for requests for interpretations (RFIs).
g. Procedures for testing and inspecting.
h. Procedures for processing Applications for Payment.
i. Distribution of the Contract Documents.
j. Submittal procedures.
k. Preparation of Record Documents.
l. Use of the premises and existing building.
m. Work restrictions.
n. Owner's occupancy requirements.
o. Responsibility for temporary facilities and controls.
p. Construction waste management and recycling.
q. Parking availability.
r. Office, work, and storage areas.
s. Equipment deliveries and priorities.
t. First aid.
u. Security.
v. Progress cleaning.
w. Working hours.

3. Minutes: Architect will record and distribute meeting minutes.

C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. The Contract Documents.
b. Options.
c. Related requests for interpretations (RFIs).
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility problems.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written recommendations.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.

t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at biweekly intervals. Coordinate dates of meetings with preparation of payment requests.

1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) Progress cleaning.
12) Quality and work standards.
13) Status of correction of deficient items.

14) Field observations.
15) Requests for interpretations (RFIs).
16) Status of proposal requests.
17) Pending changes.
18) Status of Change Orders.
19) Pending claims and disputes.
20) Documentation of information for payment requests.

3. Minutes: Record and distribute the meeting minutes.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 3100

CONSTRUCTION PROGRESS DOCUMENTATION
SECTION 01 3200

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Preliminary Construction Schedule.
2. Contractor's Construction Schedule.
3. Submittals Schedule.
4. Daily construction reports.
5. Material location reports.
6. Field condition reports.
7. Special reports.

B. Related Sections include the following:

1. Division 1 Section "Payment Procedures" for submitting the Schedule of Values.
2. Division 1 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
3. Division 1 Section "Submittal Procedures" for submitting schedules and reports.
4. Division 1 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by Architect.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.

1. Float time belongs to Owner.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Fragment: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

H. Major Area: A story of construction, a separate building, or a similar significant construction element.

I. Milestone: A key or critical point in time for reference or measurement.

J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 SUBMITTALS

A. Qualification Data: For scheduling consultant.

B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:

1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal category (action or informational).
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Architect's final release or approval.

C. Preliminary Construction Schedule: Submit two opaque copies.

1. Approval of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.

D. Preliminary Network Diagram: Submit two opaque copies, large enough to show entire network for entire construction period. Show logic ties for activities.

E. Contractor's Construction Schedule: Submit two opaque copies of initial schedule, large enough to show entire schedule for entire construction period.

1. Submit an electronic copy of schedule, using software indicated, on CD-R, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.

F. CPM Reports: Concurrent with CPM schedule, submit three copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.

G. Daily Construction Reports: Submit two copies at weekly intervals.

H. Material Location Reports: Submit two copies at weekly intervals.

I. Field Condition Reports: Submit two copies at time of discovery of differing conditions.

J. Special Reports: Submit two copies at time of unusual event.

1.5 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.

B. Pre-scheduling Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing, work stages, interim milestones, and partial Owner occupancy.
4. Review delivery dates for Owner-furnished products.
5. Review schedule for work of Owner's separate contracts.
6. Review time required for review of submittals and re-submittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for completion and startup procedures.

9. Review and finalize list of construction activities to be included in schedule.
10. Review submittal requirements and procedures.
11. Review procedures for updating schedule.

1.6 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, re-submittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

    a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

B. Time Frame: Extend schedule from date established for commencement of the Work to date of Final Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Submittal Review Time: Include review and re-submittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
3. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
3. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
4. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.

5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

a. Subcontract awards.
b. Submittals.
c. Purchases.
d. Mockups.
e. Fabrication.
f. Sample testing.
g. Deliveries.
h. Installation.
i. Tests and inspections.
j. Adjusting.
k. Curing.
l. Startup and placement into final use and operation.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.

1. Refer to Division 1 Section "Payment Procedures" for cost reporting and payment procedures.
2. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Architect's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
3. Each activity cost shall reflect an accurate value subject to approval by Architect.
4. Total cost assigned to activities shall equal the total Contract Sum.

G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

H. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.

1. MS project 1998 or newer for Windows 2000.

2.3 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for the Notice to Proceed.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.5 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (refer to special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial Completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate Actual Completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 3200

QUALITY REQUIREMENTS
SECTION 01 4000

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:

1. Division 1 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
2. Division 1 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
3. Divisions 2 through 16 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.

D. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.

E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.

F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.

K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits.

To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 SUBMITTALS

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

C. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.

d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.

a. Allow seven days for initial review and each re-review of each mockup.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed, unless otherwise indicated.

K. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Sections in Divisions 2 through 16.

1.7 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 1 Section "Submittal Procedures."

D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.

6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 30 days of date established for the Notice to Proceed.

1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.8 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

B. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.

2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
2. Comply with the Contract Document requirements for Division 1 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 4000

SECTION 014060 BIM

PART 1 – GENERAL

1.1. SUMMARY

A. The design team created the construction documents using Building Information Modeling. The architectural/engineering models will be made available to the construction team for use in creating a fully coordinated model of critical building systems as required herein.

The resulting shared Building Information Model (BIM) will be used by the construction team to review design for potential conflicts among the modeled systems, as well as other significant components/systems of the project, including partitions, doors and windows, ceilings, and fixed equipment. The BIM will also be used to provide for precise fabrication of components, coordinate integration of products and materials fabricated or installed by more than one entity, accurate field installation and reduced rework, and prompt sharing of as-built condition documentation.

B. Section includes:

1. Required coordination tasks
2. Deliverables

C. Related requirements:

1. Document 01100 – Summary
2. Section 01 3100 – Project Management and Coordination
3. Section 01 3300 – Submittal Procedures
4. Section 01 7839 – Project Record Documents
5. Section 05 1200 – Structural Steel
6. Section 05 2100 – Steel Joists
7. Section 21 0500 – Common Work Requirements for Fire Suppression
8. Section 22 0500 – Common Work Requirements for Plumbing
9. Section 23 0500 – Common Work Requirements for HVAC
10. Section 26 0500 – Common Work Requirements for Electrical
11. Section 27 0500 – Common Work Requirements for Communications

1.2 3D COORDINATION USING BUILDING INFORMATION MODELING

A. Use Building Information Modeling (BIM) to three-dimensionally coordinate critical systems and building components prior to fabrication and installation.
   1. Required trades:
      a. Structural Systems
      b. Fire Protection
      c. Plumbing
      d. HVAC
      e. Electrical
      f. Special Systems
      g. Site Utilities
   2. Additional trades and systems may be added at the Contractor’s discretion.

B. Contractor's responsibilities:
   1. Contractor shall submit a BIM execution Plan (BxP) for review and comment within 15 days after Notice of Award. Contractor shall supervise the BIM coordination effort of all trades, in conjunction with the BIM Execution Plan (BxP).
   2. The BxP shall include, at a minimum:
      a. Identify the BIM Champion or Model Manager and contact information.
      b. Establish coordination schedule milestones and meeting dates.
      c. Define required level of development and team responsibilities.
      d. Define collaboration tools and formats for information exchange.

C. Subcontractor Responsibilities
   1. All Design Intent models are to be submitted to the General Contractor's Model Manager with each scheduled deliverable including but not limited to SD, DD and CD phase deliverables.
   2. Models will be reviewed for the following but not limited to:
      a. LOD information matching what is specified in the BIM Execution Plan
      b. Cleanliness of the model
      c. Accuracy of modeled elements
      d. Model Warnings

D. All design intent models are to be handed over to the General Contractor within (15) days of bid being awarded.
   1. All information to date including any addenda content is to be incorporated in the models by the design team before model handover.

E. 3D Coordination Meetings
   1. Subcontractors providing model information and/or guidance to the detailer are required to participate in regularly scheduled coordination meetings and participate in the process of conflict resolution until process is completed as agreed upon by Owner, Architect/Engineer team and General Contractor.
   2. Owner's representative will provide oversight and compliance assistance with the 3D Coordination process outlined in the BIM Execution Plan.
   3. All models to be used during the coordination meetings are to be uploaded to the approved file sharing site one day prior to the coordination meetings as both an .NWC and/or Native file format.
   4. Attendees should include but not limited to:
      a. General Contractor
      b. Subcontractors
      c. MEP
      d. Fire Protection
      e. Design Team; Design Team participation limited to as required for review and assistance to confirm adherence to design intent, conformance to UNM standards and review of clearance requirements and assistance in resolution of building systems pathway clashes as it relates to architectural components and other building systems.
      f. Owner's Representative
   5. 3D Coordination Meetings shall occur regularly and in accordance to what is defined in the BIM execution plan, by necessity of the project and the team.

1.3 DELIVERABLES

A. Coordination Submittals

1. The BIM Coordination requirements do not relieve the contractor of, or supersede any other shop drawing/coordination drawing requirements. All requirements noted in individual specification sections for submittal of coordination drawings and shop drawings shall be strictly followed. Item or Equipment fabrications and installations that occur prior to the approval of these drawings shall be subject to removal and replacement at no additional cost to the owner. Subcontractors may use the overall Building Coordination Model to generate the coordination drawings and vice-versa.
2. Contractor shall provide written documentation of the completed coordination process to the Owner and Architect and/or Engineer, and arrange for review of the Building Information Model if desired.

B. Models throughout the design process
   1. Each coordinating subcontractor shall be responsible for maintaining and uploading to the Building Information Model any current updates, any changes or as-built conditions that impact any other trades or systems, or which materially modify the end resulting construction.
   2. Design team is responsible for maintaining their respected design intent models throughout the design process. Including but not limited to:
      a. Design assistance information
      b. Owner supplied data
      c. ASIs

C. Models throughout construction
   1. Subcontractors are responsible for incorporating information into the Construction, Fabrication and Coordination Models. This information includes, but is not limited to:
      a. RFI responses
      b. Change orders
      c. 3D Coordination – interference detection solutions
   2. Subcontractors are responsible for providing their field crew with installation drawings upon completion of systems coordination.

D. Upon completion of construction, updated Building Information Model shall be made available to the Owner and Architect/Engineer team as part of the required Close-Out Documents.

1.4 SOFTWARE

A. Software requirements will be determined per the BIM Execution Plan.

REFERENCES
SECTION 01 4200

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if

bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

D. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

ADAAG	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-0080
CFR	Code of Federal Regulations Available from Government Printing Office www.access.gpo.gov/nara/cfr	(888) 293-6498 (202) 512-1530
CRD	Handbook for Concrete and Cement Available from Army Corps of Engineers Waterways Experiment Station www.wes.army.mil	(601) 634-2355
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point www.dodssp.daps.mil	(215) 697-6257
DSCC	Defense Supply Center Columbus (See FS)	
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Department of Defense Single Stock Point www.dodssp.daps.mil	(215) 697-6257
	Available from General Services Administration www.apps.fss.gsa.gov/pub/fedspecs/index.cfm	(202) 619-8925
	Available from National Institute of Building Sciences	(202) 289-7800

	www.nibs.org	
FTMS	Federal Test Method Standard (See FS)	
MIL	See MILSPEC	
MS MIL	See MILSPEC	
MILSPEC	Military Specification and Standards Available from Department of Defense Single Stock Point www.dodssp.daps.mil	(215) 697-6257
UFAS	Uniform Federal Accessibility Standards Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-5434

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The) www.aluminum.org	(202) 862-5100
AAADM	American Association of Automatic Door Manufacturers www.aaadm.com	(216) 241-7333
AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials www.aashto.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists (The) www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association	(202) 367-1155

	www.abma-dc.org	
ACI	American Concrete Institute/ACI International www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AFPA	American Forest & Paper Association (See AF&PA)	
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AHA	American Hardboard Association www.hardboard.org	(847) 934-8800
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction www.aitc-glulam.org	(303) 792-9559
ALCA	Associated Landscape Contractors of America www.alca.org	(800) 395-2522 (703) 736-9666
ALSC	American Lumber Standard Committee, Incorporated www.alsc.org	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc.	(847) 394-0150

	www.amca.org	
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts www.aosaseed.com	(505) 522-1437
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute www.ari.org	(703) 524-8800
ARMA	Asphalt Roofing Manufacturers Association www.asphaltroofing.org	(202) 207-0917
ASCA	Architectural Spray Coaters Association www.ascassoc.com	(856) 848-6120
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (212) 591-7722
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9585
AWCI	AWCI International (Association of the Wall and Ceiling Industries International) www.awci.org	(703) 534-8300
AWCMA	American Window Covering Manufacturers Association (See WCSC)	

AWI	Architectural Woodwork Institute www.awinet.org	(800) 449-8811 (703) 733-0600
AWPA	American Wood-Preservers' Association www.awpa.com	(817) 326-6300
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.bia.org	(703) 620-0010
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International) www.bifma.com	(616) 285-3963
CCC	Carpet Cushion Council www.carpetcushion.org	(203) 637-1312
CCFSS	Center for Cold-Formed Steel Structures www.umr.edu/~ccfss	(573) 341-4471
CDA	Copper Development Association Inc. www.copper.org	(800) 232-3282 (212) 251-7200
CEA	Canadian Electricity Association www.canelect.ca	(514) 866-6121
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CGSB	Canadian General Standards Board www.pwgsc.gc.ca/cgsb	(819) 956-0425
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute	(423) 892-0137

	www.cispi.org	
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPPA	Corrugated Polyethylene Pipe Association www.cppa-info.org	(800) 510-2772 (202) 462-9607
CRI	Carpet & Rug Institute (The) www.carpet-rug.com	(800) 882-8846 (706) 278-3176
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(800) 463-6727 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
EIA	Electronic Industries Alliance www.eia.org	(703) 907-7500
EIMA	EIFS Industry Members Association www.eima.com	(800) 294-3462 (770) 968-7945
EJCDC	Engineers Joint Contract Documents Committee www.asce.org	(800) 548-2723 (703) 295-6300
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association	(315) 339-6937
FCI	Fluid Controls Institute www.fluidcontrolsinstitute.org	(216) 241-7333
FGMA	Flat Glass Marketing Association (See GANA)	

FM	Factory Mutual System (See FMG)	
FMG	FM Global (Formerly: FM - Factory Mutual System) www.fmglobal.com	(401) 275-3000
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridaroof.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council www.fscoax.org	52 951 5146905
GA	Gypsum Association www.gypsum.org	(202) 289-5440
GANA	Glass Association of North America (Formerly: FGMA - Flat Glass Marketing Association) www.glasswebsite.com	(785) 271-0208
GRI	Geosynthetic Research Institute www.drexel.edu/gri	(215) 895-2343
GTA	Glass Tempering Division of Glass Association of North America (See GANA)	
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
HI	Hydronics Institute www.gamanet.org	(908) 464-8200
HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAS	International Approval Services (See CSA)	
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(770) 830-0369

ICRI	International Concrete Repair Institute, Inc. www.icri.org	(847) 827-0830
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IESNA	Illuminating Engineering Society of North America www.iesna.org	(212) 248-5000
IGCC	Insulating Glass Certification Council www.igcc.org	(315) 646-2234
IGMA	Insulating Glass Manufacturers Alliance (The) www.igmaonline.org	(613) 233-1510
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
ISSFA	International Solid Surface Fabricators Association www.issfa.net	(702) 567-8150
ITS	Intertek Testing Services www.itsglobal.com	(800) 345-3851 (607) 753-6711
IWS	Insect Screening Weavers Association (Now defunct)	
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LMA	Laminating Materials Association www.lma.org	(201) 664-2700
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864 (847) 577-7200
LSGA	Laminated Safety Glass Association (See GANA)	
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MFMA	Maple Flooring Manufacturers Association www.maplefloor.org	(847) 480-9138
MFMA	Metal Framing Manufacturers Association www.metalframingmfg.org	(312) 644-6610

MH	Material Handling Industry of America (See MHIA)	
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(440) 250-9222
MPI	Master Painters Institute www.paintinfo.com	(888) 674-8937
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(312) 332-0405
NAAMM	North American Association of Mirror Manufacturers (See GANA)	
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(281) 228-6200
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAIMA	North American Insulation Manufacturers Association (The) www.naima.org	(703) 684-0084
NAMI	National Accreditation and Management Institute, Inc.	(304) 258-5100
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(262) 248-9094
NCTA	National Cable & Telecommunications Association www.ncta.com	(202) 775-3550
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association	(301) 657-3110

	www.necanet.org	
NeLMA	Northeastern Lumber Manufacturers' Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(303) 697-8441
NFPA	NFPA International (National Fire Protection Association International) www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NGA	National Glass Association www.glass.org	(703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association www.nofma.org	(901) 526-5016
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo and Mosaic Association, Inc. www.ntma.com	(800) 323-9736 (703) 779-1022
NTRMA	National Tile Roofing Manufacturers Association (See RTI)	
NWWDA	National Wood Window and Door Association (See WDMA)	

OPL	Omega Point Laboratories, Inc. www.opl.com	(800) 966-5253 (210) 635-8100
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDCA	Painting and Decorating Contractors of America www.pdca.com	(800) 332-7322 (703) 359-0826
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (508) 230-3516
PGI	PVC Geomembrane Institute www.pgi-tp.ce.uiuc.edu	(217) 333-3929
RCSC	Research Council on Structural Connections www.boltcouncil.org	(800) 644-2400 (312) 670-2400
RFCI	Resilient Floor Covering Institute www.rfci.com	Contact by mail only
RIS	Redwood Inspection Service www.calredwood.org	(888) 225-7339 (415) 382-0662
RTI	Roof Tile Institute (Formerly: NTRMA - National Tile Roofing Manufacturers Association) www.ntrma.org	(541) 689-0366
SAE	SAE International www.sae.org	(724) 776-4841
SDI	Steel Deck Institute www.sdi.org	(847) 462-1930
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association www.sefalabfurn.com	(516) 294-5424
SGCC	Safety Glazing Certification Council www.sgcc.org	(315) 646-2234
SIA	Security Industry Association www.siaonline.org	(703) 683-2075
SIGMA	Sealed Insulating Glass Manufacturers Association (See IGMA)	

SJI	Steel Joist Institute www.steeljoist.org	(843) 626-1995
SMA	Screen Manufacturers Association	(561) 533-0991
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980
SMPTE	Society of Motion Picture and Television Engineers www.smpte.org	(914) 761-1100
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division) www.sprayfoam.org	(800) 523-6154
SPIB	Southern Pine Inspection Bureau (The) www.spib.org	(850) 434-2611
SPI/SPFD	Society of the Plastics Industry, Inc. (The) Spray Polyurethane Foam Division (See SPFA)	
SPRI	SPRI (Single Ply Roofing Institute) www.spri.org	(781) 647-7026
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
SWRI	Sealant, Waterproofing, & Restoration Institute www.swrionline.org	(816) 472-7974
TCA	Tile Council of America, Inc. www.tileusa.com	(864) 646-8453
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance www.tiaonline.org	(703) 907-7700

TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute, Inc. www.tpinst.org	(608) 833-5900
TPI	Turfgrass Producers International www.turfgrasssod.org	(800) 405-8873 (847) 705-9898
UL	Underwriters Laboratories Inc. www.ul.com	(800) 704-4050 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USITT	United States Institute for Theatre Technology, Inc. www.usitt.org	(800) 938-7488 (315) 463-6463
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association (See WCSC)	
WCSC	Window Covering Safety Council (Formerly: WCMA - Window Covering Manufacturers Association) www.windowcoverings.org	(800) 506-4636 (212) 661-4261
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association) www.wdma.com	(800) 223-2301 (847) 299-5200
WIC	Woodwork Institute of California www.wicnet.org	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association www.wmmpa.com	(800) 550-7889 (530) 661-9591
WSRCA	Western States Roofing Contractors Association www.wsrca.com	(800) 725-0333 (650) 548-0112
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

BOCA	BOCA International, Inc. www.bocai.org	(708) 799-2300
CABO	Council of American Building Officials (See ICC)	
IAPMO	International Association of Plumbing and Mechanical Officials (The) www.iapmo.org	(909) 595-8449
ICBO	International Conference of Building Officials www.icbo.org	(800) 284-4406 (562) 699-0541
ICBO ES	ICBO Evaluation Service, Inc. www.icbo.org/ICBO_ES/	(800) 423-6587
ICC	International Code Council, Inc. (Formerly: CABO - Council of American Building Officials) www.intlcode.org	(703) 931-4533
SBCCI	Southern Building Code Congress International, Inc. www.sbcci.org	(205) 591-1853

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CE	Army Corps of Engineers www.usace.army.mil	
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-0990
DOC	Department of Commerce www.doc.gov	(202) 482-2000
EPA	Environmental Protection Agency	(202) 260-2090

	www.epa.gov	
FAA	Federal Aviation Administration www.faa.gov	(202) 366-4000
FDA	Food and Drug Administration www.fda.gov	(888) 463-6332
GSA	General Services Administration www.gsa.gov	(202) 708-5082
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley Laboratory (See LBNL)	
LBNL	Lawrence Berkeley National Laboratory www.lbl.gov	(510) 486-5605
NCHRP	National Cooperative Highway Research Program (See TRB)	
NIST	National Institute of Standards and Technology www.nist.gov	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742 (202) 693-1999
PBS	Public Building Service (See GSA)	
RUS	Rural Utilities Service (See USDA)	(202) 720-9540
SD	State Department www.state.gov	(202) 647-4000
TRB	Transportation Research Board www.nas.edu/trb	(202) 334-2934
USDA	Department of Agriculture www.usda.gov	(202) 720-2791
USPS	Postal Service www.usps.com	(202) 268-2000

E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following

list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CAPUC (See CPUC)

CBHF	State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation www.dca.ca.gov/bhfti	(800) 952-5210 (916) 574-2041
CPUC	California Public Utilities Commission www.cpuc.ca.gov	(415) 703-2782
TFS	Texas Forest Service Forest Products Laboratory www.txforestservice.tamu.edu	(936) 639-8180

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 4200

TEMPORARY FACILITIES AND CONTROLS
SECTION 01 5000

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Sections include the following:

1. Division 1 Section "Summary" for limitations and work restrictions.
2. Division 1 Section "Execution Requirements" for progress cleaning requirements.
3. Division 1 Section “Construction Waste Management”
4. Divisions 2 through 16 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.
5. Division 2 Section "Asphaltic Concrete Paving" for construction and maintenance of asphalt paving for temporary roads and paved areas.

1.3 DEFINITIONS

A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weather tight; exterior walls are insulated and weather tight; and all openings are closed with permanent construction or substantial temporary closures.

1.4 USE CHARGES

A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.

B. Sewer Service: Pay sewer service use charges for sewer usage by all entities for construction operations.

C. Water Service: Pay water service use charges for water used by all entities for construction operations.

D. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.

1.5 SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

1.6 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.7 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber and Plywood: Comply with requirements in Division 6 Section "Rough Carpentry Miscellaneous Carpentry."

B. Gypsum Board: Minimum 1/2 inch (12.7 mm) thick by 48 inches (1219 mm) wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36/C 36M.

C. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

D. Paint: Comply with requirements in Division 9 painting Sections.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. Heating Equipment: Unless Owner authorizes use of permanent heating system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

B. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

C. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

F. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on

completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

G. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide non-combustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
3. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare sub-grade and install sub-base and base for temporary roads and paved areas according to Division 2 Section "Earthwork."
3. Recondition base after temporary use, including removing contaminated material, re-grading, proof-rolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 2 Section "Hot-Mix Asphalt Paving."

C. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

D. Project Identification and Temporary Signs: Provide Project identification and other signs. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.

1. Provide temporary, directional signs for construction personnel and visitors.
2. Maintain and touchup signs so they are legible at all times.

E. Waste Disposal Facilities: Comply with requirements specified in Division 1 Section "Construction Waste Management." Comply with requirements of authorities having jurisdiction.

F. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Division 1 Section "Summary."

B. Storm water Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and sub-grade construction to prevent flooding by runoff of storm water from heavy rains.

C. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

D. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

E. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

F. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather-tight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

G. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.

1. Prohibit smoking in construction areas.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 1 Section "Closeout Procedures."

END OF SECTION 01 5000

PRODUCT REQUIREMENTS
SECTION 01 6000

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. Related Sections include the following:

1. Division 01 Section "References" for applicable industry standards for products specified.
2. Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
3. Divisions 02 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.4 SUBMITTALS

A. Product List: Submit a list, in tabular from, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.

1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
2. Form: Tabulate information for each product under the following column headings:

a. Specification Section number and title.
b. Generic name used in the Contract Documents.
c. Proprietary name, model number, and similar designations.
d. Manufacturer's name and address.
e. Supplier's name and address.
f. Installer's name and address.
g. Projected delivery date or time span of delivery period.
h. Identification of items that require early submittal approval for scheduled delivery date.

3. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.

a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.

4. Completed List: Within 60 days after date of commencement of the Work, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
5. Architect's Action: Architect will respond in writing to Contractor within 15 days of receipt of completed product list. Architect's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Architect's response, or lack of response, does not constitute a waiver of requirement to comply with the Contract Documents.

B. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
a. Statement indicating why specified material or product cannot be provided.

b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
j. Cost information, including a credit proposal of change, if any, in the Contract Sum.
k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
   a. Form of Acceptance: MCR to be followed by a Change Order.
   b. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.

1.6 PRODUCT MANUFACTURER PRIOR APPROVAL

A. Prior Approvals will be accepted up to fourteen days prior to bid

1.7 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

B. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

C. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

D. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.9 PRODUCT WARRANTIES

E. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

F. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
3. Refer to Divisions 02 through 49 Sections for specific content requirements and particular requirements for submitting special warranties.

G. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Part 2 "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.

4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

    a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.

10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.

    a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

A. Substitution of equipment or materials other than these specified will be approved by the Architect only if the following conditions exist – use the attached Substitution Request Form following this Section:

1. Materials specified and ordered in a timely manner cannot be delivered to the job in time to complete the work in proper sequence, and;

2. If an equal or superior material is proposed, and;

3. If a difference in price can accrue to the Owner;

B. Or the specified product or equipment is no longer available

2.3 PRODUCT MANUFACTURER PRIOR APPROVAL

A. Ten (10) calendar days prior to the date for opening bids the Architect will accept requests for materials and products which are not named in the specifications.

1. Submit information, which describes the products for comparative/ equal purposes.
2. Acceptable manufacturers and product will be issued by addenda within 3 days of bid opening.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 6000

EXECUTION REQUIREMENTS
SECTION 01 7000

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. General installation of products.
4. Coordination of Owner-installed products.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of the Work.

B. Related Sections include the following:

1. Division 1 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
2. Division 1 Section "Submittal Procedures" for submitting surveys.
3. Division 1 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
4. Division 1 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 SUBMITTALS

A. Qualification Data: For professional engineer.

B. Certificates: Submit certificate signed by professional engineer certifying that location and elevation of improvements comply with requirements.

C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.

1. Before construction, verify the location and points of connection of utility services.

B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

    a. Description of the Work.
    b. List of detrimental conditions, including substrates.
    c. List of unacceptable installation tolerances.
    d. Recommended corrections.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility

appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2A, "Request for Interpretation."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect and Construction Manager promptly.

3.4 FIELD ENGINEERING

A. Identification: Owner will identify existing benchmarks, control points, and property corners.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
4. Maintain minimum headroom clearance of 8 feet (2.4 m) in spaces without a suspended ceiling.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction forces.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.

1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
2. Pre-installation Conferences: Include Owner's construction forces at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 1 Section "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 1 Section "Cutting and Patching."

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 7000

CLEANING
SECTION 01 7100

PART 1 GENERAL

1.01 WORK INCLUDED

A. The scope of the Work shall include, but shall not necessarily be limited to, the provision of labor, equipment, materials, and other incidentals necessary to accomplish the continuous during construction, and final cleaning of the site, as shown on the drawings and described in the specifications.

B. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. During the course of the Work, excess waste materials shall be continuously and promptly removed. All reasonable precautions shall be taken to avoid damage to existing utilities and improvements, including sprinklers, plants, and lawns.

B. The washing of concrete trucks and chutes, and the dumping of excess concrete or other cementitious material on site shall not be allowed, except at location(s) approved by the Owner specifically, and directed by the Architect. At the completion of the Work, the Contractor shall be required to remove from the site and properly dispose of all such dumped materials, including the surrounding soils contaminated thereby.

C. All paint residues and vehicle deposits such as oils and fuels which, due to the course of the work, contaminate site soils shall be removed together with the contaminated soils, and such soils shall be replaced if required, with equal soils, clean and uncontaminated. In no case shall any contaminated soil or soils contaminating material or substance (including paints, oils, fuels, and cements) be turned under at the site during grading or fill operations.

D. Provide on-site containers for collection of waste materials, debris and rubbish

E. Remove waste materials, debris and rubbish from site periodically and legally dispose of it at dumping areas off Owner's property.

3.02 DUST CONTROL

A. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

B. Clean interior spaces when ready to receive finish painting and continue cleaning on an as-needed basis until building is ready for Substantial Completion or occupancy.

C. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.

3.03 FINAL CLEANING

A. General: Special cleaning for specific units of work is specified in sections of Division 2 through 16. Provide final cleaning of the work, at time indicated, consisting of cleaning each surface or unit of work to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with manufacturer's instructions for cleaning operations. The following are examples, but not by way of limitation, of cleaning levels required:

B. Prior to Substantial Completion of the Work, remove all surplus material, false-work, temporary structures, plants and debris of any kind. If final clean-up is carried out too early and the work becomes dirty due to subsequent operations under this contract, the work shall be re-cleaned as required.

C. Employ experienced workmen, or professional cleaners for final cleaning.

D. In preparation for Substantial Completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces and of concealed spaces.
   1. Metal: Remove protective coverings and other foreign matter from integrally or factory finished metals. Use care not to scratch finish. Wash, rinse, and dry interior surfaces.
   2. Floors: Remove temporary floor protections. Remove stains, spotting and soiling. Vacuum all carpeted areas; dust and damp mop all hard surface floors and clean in accordance with material or manufacturer's directions.
   3. Other Surfaces: Remove marks, stains, dust and other soiling from painted, decorated or stained work. Clean and polish hardware and laminated plastic. Remove dirt and dust from other fixtures and equipment.

E. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from sight-exposed interior and exterior finished surfaces; polish surfaces so designated to shine finish.

F. Repair patch and touch-up marred surfaces to specified finish to match adjacent surfaces.

G. Remove labels which are not required as permanent labels.

H. Clean transparent materials, including mirrors and window/door glass, to a polished condition, removing substances which are noticeable as vision-obscuring materials.

Replace broken glass and damaged transparent materials. Prevent damage to reflective films on glass.

I. Clean exposed exterior and interior hard-surfaced finishes, to a dirt-free condition, free of dust, stains, films and similar noticeable distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition.

J. Remove debris and surface dust from limited-access spaces including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics and similar spaces.

K. Clean concrete floors in non-occupied spaces broom clean.

L. Clean plumbing fixtures to a sanitary condition, free of stains including those resulting from water exposure.

M. Replace air conditioning filters if units are operated during construction.

N. Clean ducts, blowers and coils if air conditioning units were operated without filters during construction.

O. Wipe surfaces of mechanical and electrical equipment clean, remove excess lubrication and other substances.

P. Clean light fixtures and lamps so as to function with full efficiency.

1. Clean project site (yard and grounds), including landscape development areas, of litter and foreign substances. Sweep paved areas to a broom-clean condition; remove stains, petrochemical spills and other foreign deposits. Rake grounds which are neither planted nor paved, to a smooth, even-textured surface, leaving no solid stones, mortars, aggregates, other solid matter or material exposed on the surface in excess of 3/4 inch in size when measured in any direction.

Q. Removal of Protection: Except as otherwise indicated or requested by Architect, remove temporary protection devices and facilities which were installed during course of the work to protect previously completed work during remainder of construction period.

R. Compliances: Comply with safety standards and governing regulations for cleaning operations. Do not burn waste materials at site, or bury debris or excess materials on Owner's property, or discharge volatile or other harmful or dangerous materials into drainage systems; remove waste materials from site and dispose of in a lawful manner.

S. Owner will assume responsibility for cleaning as of time designated on Certificate of Substantial Completion for Owner's acceptance of project or portion thereof.

3.04 INSPECTIONS AND ACCEPTANCE

A. The final cleanup may be performed in section or areas and at times as agreed to by the Architect. After the acceptance of each area, re-raking shall not be again required to remove over-sized materials dislodged and brought to the surface by non-construction traffic or erosion. Only the re-raking of accepted areas which are later disturbed by the

Contractor, his employees, delivery persons and vehicles, or others in the performance of the Work or access thereto shall be required.

END OF SECTION 01 7100

CUTTING AND PATCHING
SECTION 01 7310

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:

1. Division 1 Section "Selective Demolition" for demolition of selected portions of the building.
2. Divisions 2 through 16 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
3. Division 7 Section "Through-Penetration Fire Stop Systems" for patching fire-rated construction.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be

relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.

6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-suppression systems.
4. Mechanical systems piping and ducts.
5. Control systems.
6. Communication systems.
7. Conveying systems.
8. Electrical wiring systems.
9. Operating systems of special construction in Division 13 Sections.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain-wall construction.
4. Equipment supports.
5. Piping, ductwork, vessels, and equipment.
6. Noise- and vibration-control elements and systems.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or re-hang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather-tight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 01 7310

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Sections:

1. Division 01 Section "Multiple Contract Summary" for coordination of responsibilities for waste management.
2. Division 02 Section "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements.
3. Division 02 Section "Selective Structure Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.
4. Division 04 Section "Unit Masonry" for disposal requirements for masonry waste.
5. Division 04 Section "Stone Masonry" for disposal requirements for excess stone and stone waste.
6. Division 31 Section "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 PERFORMANCE REQUIREMENTS

A. General: Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:

a. Asphaltic concrete paving.
b. Concrete.
c. Concrete reinforcing steel.
d. Brick.
e. Concrete masonry units.
f. Wood studs.
g. Wood joists.
h. Wood paneling.
i. Wood trim.
j. Structural and miscellaneous steel.
k. Rough hardware.
l. Roofing.
m. Insulation.
n. Doors and frames.
o. Door hardware.
p. Windows.
q. Glazing.
r. Metal studs.
s. Carpet pad.
t. Demountable partitions.
u. Equipment.
v. Cabinets.
w. Plumbing fixtures.
x. Piping.
y. Supports and hangers.
z. Valves.
aa. Sprinklers.
bb. Mechanical equipment.
cc. Refrigerants.
dd. Electrical conduit.
ee. Copper wiring.
ff. Lighting fixtures.
gg. Lamps.
hh. Ballasts.
ii. Electrical devices.
jj. Switchgear and panelboards.

kk. Transformers.

2. Construction Waste:

a. Site-clearing waste.
b. Masonry and CMU.
c. Lumber.
d. Wood sheet materials.
e. Wood trim.
f. Metals.
g. Roofing.
h. Insulation.
i. Carpet and pad.
j. Gypsum board.
k. Piping.
l. Electrical conduit.
m. Packaging: Regardless of salvage/recycle goal indicated in paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Plastic pails.
8) Wood pallets.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 15 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Each progress report shall include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. Qualification Data: For waste management coordinator and refrigerant recovery technician.

H. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of Projects with similar requirements, that employs a LEED Accredited Professional, certified by USGBC, as waste management coordinator. Waste management coordinator may also serve as LEED coordinator.

B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.

5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements of this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in hauling and tipping fees by donating materials.
7. Savings in hauling and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with Division 01 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

1. Distribute waste management plan to everyone concerned within five days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted on Project site.

C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

F. Plumbing Fixtures: Separate by type and size.

G. Lighting Fixtures: Separate lamps by type and protect from breakage.

H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Receivers and Processors: Contractor shall be responsible for finding available recycling receivers and processors. Refer to www.nmrecycle.org for list of local recycling receivers and processors.

C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

D. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

E. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

    a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.

5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

A. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility.

B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

C. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Transport to recycling facility.

D. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

E. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware..

F. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

G. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

H. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

I. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Site-Clearing Wastes: Chip brush, branches, and trees at landfill facility.

C. Metals: separate metals as required by recycling facility.

D. Concrete: break up and transport concrete waste to recycling facility.

E. Masonry: break up and transport masonry waste to recycling facility.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 017419

CLOSEOUT PROCEDURES
SECTION 01 7700

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Inspection procedures.
2. Warranties.
3. Final cleaning.

B. Related Sections include the following:

1. Division 1 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
2. Division 1 Section "Execution Requirements" for progress cleaning of Project site.
3. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
4. Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
5. Divisions 2 through 16 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete. All punch list items shall be completed by the date established for Substantial Completion in the Contract for Construction.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Tenant unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
7. Make final changeover of permanent locks and deliver keys to Tenant. Advise Owner's personnel of changeover in security provisions.
8. Complete startup testing of systems.
9. Submit test/adjust/balance records.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued. All punch list items shall be completed by the date established for Substantial Completion in the Contract for Construction.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Instruct Tenant's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor

of construction that must be completed or corrected before certificate will be issued. All punch list items shall be completed by the date established for Substantial Completion in the Contract for Construction.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use CSI Form 14.1A.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect.
    d. Name of Contractor.
    e. Page number.

1.6 WARRANTIES

A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Tenant during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

    a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    b. Remove tools, construction equipment, machinery, and surplus material from Project site.
    c. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    d. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    e. Sweep concrete floors broom clean in unoccupied spaces.
    f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
    g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
    h. Remove labels that are not permanent.
    i. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

j. Wipe surfaces of mechanical and electrical equipment, medical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
k. Replace parts subject to unusual operating conditions.
l. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
m. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
n. Clean ducts, blowers, and coils if units were operated without filters during construction.
o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
p. Leave Project clean and ready for occupancy.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Tenant's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01 7700

PROJECT RECORD DOCUMENTS
SECTION 01 7810

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record Specifications.

B. Related Sections include the following:

1. Division 1 Section "Closeout Procedures" for general closeout procedures.
2. Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
3. Divisions 2 through 16 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit 2 set(s) of marked-up Record Prints.

B. Record Specifications: Submit 2 copies of Project's Specifications, including addenda and contract modifications.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an understandable drawing technique.

c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Revisions to routing of piping and conduits.
d. Revisions to electrical circuitry.
e. Actual equipment locations.
f. Duct size and routing.
g. Locations of concealed internal utilities.
h. Changes made by Change Order or Construction Change Directive.
i. Changes made following Architect's written orders.

3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Transparencies: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Architect. When authorized, prepare a full set of corrected transparencies of the Contract Drawings and Shop Drawings.

1. Incorporate changes and additional information previously marked on Record Prints. Erase, redraw, and add details and notations where applicable.
2. Refer instances of uncertainty to Architect for resolution.
3. Print the Contract Drawings and Shop Drawings for use as Record Transparencies. Architect will make the Contract Drawings available to Contractor's print shop.

C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing Record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.

1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

D. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Record Transparencies: Organize into unbound sets matching Record Prints. Place transparencies in durable tube-type drawing containers with end caps. Mark end cap of each container with identification. If container does not include a complete set, identify Drawings included.
3. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Architect.
e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders and Record Drawings where applicable.

2.3 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

END OF SECTION 01 7810

OPERATION AND MAINTENANCE DATA
SECTION 01 7820

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation manuals for systems, subsystems, and equipment.
2. Maintenance manuals for the care and maintenance of [products, materials, and finishes] [systems and equipment].

B. Related Sections include the following:

1. Division 1 Section "Summary" for coordinating operation and maintenance manuals covering the Work of multiple contracts.
2. Division 1 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
3. Division 1 Section "Closeout Procedures" for submitting operation and maintenance manuals.
4. Division 1 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
5. Divisions 2 through 16 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

A. Final Submittal: Submit one copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.

1. Correct or modify each manual to comply with Architect's comments. Submit 3 copies of each corrected manual within 15 days of receipt of Architect's comments.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Tenant.
4. Date of submittal.
5. Name, address, and telephone number of Contractor.
6. Name and address of Architect.
7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.

4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.3 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Tenant's operating personnel.

C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams.

Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.

1. Do not use original Project Record Documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared Record Drawings in Division 1 Section "Project Record Documents."

E. Comply with Division 1 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 7820

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Training of Owner's designated personnel in operation and maintenance of equipment and systems.

B. Related sections:

1. Section 01 77 00 - Closeout Submittals: Operation and maintenance manuals.

1.2 SUBMITTALS

A. Provide in accordance with Section 01 33 00 - Submittal Procedures:

1. List of names, resumes, and qualifications of personnel conducting training sessions.
2. Preliminary schedule listing times, dates, and outline showing organization and proposed contents of training sessions for approval by Architect and Owner.
3. Copies of training manuals and other materials to be used in training sessions for approval by Architect and Owner.
4. Provide Owner additional copy of audio visual material on the same media used in training sessions.
5. 3 copies of training manuals for future use in training by Owner.
6. Submit report within 1 week after completion of training that sessions have been satisfactorily completed. Give times, dates, list of persons trained, and summary of instructions.

1.3 QUALITY ASSURANCE

A. Personnel conducting demonstration and training sessions shall be knowledgeable of installation, operation, and maintenance of specific project equipment and systems. Where appropriate manufacturer's representatives shall conduct training.

PART 2- PRODUCTS

2.1 TRAINING MATERIALS

A. Training manuals: Loose leaf notebook format with agenda and objectives of each lesson.

1. Manuals shall describe function, operation, and maintenance of various items of equipment and be suitable for personnel with high school education.
2. Manuals shall be suitable for future training of Owner personnel by Owner staff.
3. Manuals shall contain useful reference for staff maintaining facility.

B. Visual aids: Provide charts, handouts, overhead projector slides, electronic presentations, and other visual aids required to make effective presentation and facilitate training.

1. Equipment needed for showing visual training aids shall be provided by Contractor.
2. Visual aids shall be suitable for use by Owner's staff to train additional personnel in the future.

PART 3 - EXECUTION

2.1 SCHEDULING

A. Schedule demonstration and training sessions after equipment and systems have been completely installed, startup completed, and adjustments made. Single demonstration and training session shall be conducted of all items prior to substantial completion. Schedule with Architect to accommodate Owner's representatives.

2.2 DEMONSTRATION AND TRAINING

A. Provide demonstration and training session to emphasize operation, use, and maintenance of installed items and systems:

1. Systems and items noted in specification sections.
2. Elevator specified in Section 14 24 00 - Hydraulic Elevator.
3. Mechanical systems specified in Divisions 21 through 23 - Mechanical.
4. Electrical systems specified in Divisions 26 through 28 - Electrical.
5. Other items and systems as designated by Architect or requested by Owner.

B. Conduct at project site using actual installed equipment and systems.

C. Owner shall be responsible for designating and notifying personnel to attend and ensuring attendance at scheduled sessions.

D. Have copies of operation and maintenance manuals specified in Section 01 78 23 – Operation and Maintenance Data. Use as training aids.

E. Owner shall have right to record or video tape demonstration and training sessions.

END OF SECTION

SECTION 024100 - GENERAL SITE REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

A. The extent of general site requirements is shown on drawings and specified herein, including but not limited to:

1. Site work general requirements.

2. Protection of Landscaping.

3. Traffic control.

4. Protection of utility systems.

5. Construction water supply (Site work).

6. Historical preservation.

7. Material Testing (Site work).

1.3 LIMITATIONS:

A. Owner assumes no responsibility for actual condition of existing structures and utilities crossing, and/or adjacent to this project. It shall be the sole responsibility of the Contractor to be protected all structures and utilities in place.

1.4 QUALITY ASSURANCE:

A. Codes, standards, and regulations referenced herein.

B. Work within the public right-of-way shall conform to the rules and regulations of the City of Las Cruces and New Mexico State University. All such work shall be subject to the inspection and acceptance of the work by the City of Las Cruces and New Mexico State University. The Owner will assist the Contractor with obtaining all required permits.

1.5 RELATED WORK SPECIFIED ELSEWHERE:

A. GENERAL REQUIREMENTS

B. SITE WORK

C. City of Las Cruces and New Mexico State University guidelines.

1.6 SUBMITTALS:

A. Traffic control plans for each sequence of the construction.

B. Copy of all permits, inspection forms, and correspondence with the CID.

C. Support and bracing details for the support of existing utilities, tunnel, vaults and structures that are effected by construction activities.

D. Construction survey cut sheets and as-built information.

PART 2 - PRODUCTS

Not applicable

PART 3 - EXECUTION

3.1 PERMITS

A. The Contractor shall obtain all required permits. The Contractor shall comply with all provisions of the permits and comply with all governing Federal, State, and Local regulations pertaining to environmental protection.

3.2 SITE WORK – GENERAL REQUIREMENTS:

A. Removal of existing improvements and obstructions shall conform to Section 024116 – STRUCTURE DEMOLITION and 310000 EARTHWORK.

B. Blasting and the use of explosives shall not be permitted on the site.

C. Conduct demolition, stockpiling and removal operations to ensure minimum interference with roads, streets, sidewalks, bike lanes, other adjacent facilities, and landscaping.

D. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the Owner and/or the University.

E. Protect adjacent structures, improvements, and landscaping from damage caused by demolition and other construction operations. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished or modified, and adjacent facilities to remain. The Contractor, at their sole expense, shall repair all adjacent structures and improvements that are damaged to the satisfaction of the Owner.

F. Chain link fence shall be erected at Construction Limits. Fence shall be locked at all gates when work is not in progress.

3.3 DUST CONTROL:

A. Use water sprinkling and other dust palliative method to limit dust and dirt rising and scattering into the air to lowest practical level. All costs associated with claims and complaints for dust and debris damage and nuisance to people or property shall be borne solely by the Contractor.

B. Do not use or apply water, or other dust palliative technique, in such that it may create hazardous or objectionable conditions such as ice, flooding, and/or stormwater pollution.

3.4 DISPOSAL OF DEMOLISHED AND EXCESS MATERIALS:

A. Promptly remove all debris, rubbish, excess materials and other materials resulting from demolition operations from the site. Do not permit debris and rubbish to accumulate on the site. See 017410 CONSTRUCTION WASTE MANAGEMENT.

B. Burning of materials shall not be permitted on site.

C. All materials not scheduled to be salvaged shall become the property of the Contractor.

D. Dispose of all materials in accordance with all governing regulations and per 017410 CONSTRUCTION WASTE MANAGEMENT.

E. Items of salvageable value to Contractor, which have not been identified for salvage by the Owner may be removed as, work progresses. Salvaged items shall be transported off-site as they are removed.

3.5 SALVAGE MATERIALS:

A. Salvaged materials and equipment, other than landscaping and landscape surfacing, shall be disassembled and removed only at connections. No field cutting shall be permitted without written approval of the Owner.

B. The Contractor shall protect the salvaged equipment from damage and store all items in such a manner as to protect the items from damage and vandalism. The Contractor shall replace all damaged items.

3.6 PROTECTION OF LANDSCAPING:

A. The Contractor shall be responsible to protect all trees and shrubs located adjacent to the construction area. Existing trees/shrubs subject to construction damage shall be fenced, or otherwise protected before any work is started. The method of protection and the dimensions of the protection devices shall be determined by the University's Grounds Department in conjunction with the Contractor. Once installed, fencing or other protection device shall be removed without prior approval of the Owner, and there shall be no construction activity or material storage within the fenced areas.

B. Small trees and shrubs, as determined by the Owner, shall be fenced in such a manner as to encompass the entire drip line area of the tree. In no case shall the enclosure be less than 66% of the radius of the canopy from the trunk of the tree or two (2) feet from a shrub.

C. Medium and large trees shall be fenced in a manner determined by the University Grounds Department based on sound arboricultural practices. In no case shall the protective device be closer than 66% of the radius of the canopy from the trunk of the tree except in those portions bordered by a street or roadway, in which case the protective device shall be offset one (1) foot from the edge of pavement or back of curb.

D. When trimming or pruning of trees and shrubs is required, the Contractor shall coordinate all such requirements with the owner two weeks in advance. The University Grounds Department shall carry out all trimming and pruning of trees and shrubs.

E. Promptly report all damages to trees and shrubs to the Owner. The University Grounds Department will review the damage and recommend repairs or replacements.

F. In the event any tree or shrub outside the construction area, or indicated on the plans to remain, is damaged by construction activities, and the Owner determines that it should be replaced, the Contractor shall remove the tree or shrub. The University Grounds Department shall replace the tree or shrub at the sole cost of the Contractor.

3.7 JOB SITE SAFETY:

A. It shall be the Contractor's sole responsibility to ensure safety within, and adjacent to the construction site.

B. The Contractor shall install all barriers and traffic control devices to protect the safety of the site and areas adjacent to the site. Refer to paragraph TRAFFIC CONTROL for additional requirements. All excavations and slope banks shall be barricaded to protect the safety of pedestrians and vehicular traffic.

C. The contractor shall comply with all O.S.H.A. safety rules and requirements, including working within confined spaces.

D. The contractor shall be solely responsible for the design, installation, and maintenance of all shoring and bracing.

3.8 TRAFFIC CONTROL:

A. Project access is limited to the South. Existing utilities and tunnels along Espina and Frenger must not be crossed by any vehicle.

B. The requirement of the traffic control for this project is to provide safe and continued pedestrian, bicycle, and vehicular circulation around the construction site with minimize adverse impact on the campus activities and the community.

C. The Contractor shall be responsible to prepare a traffic control plan acceptable to the Owner, and install and maintain all traffic control devices required during construction. Devices installed within the public right-of-way shall be reviewed and approved by the New Mexico State University. The Contractor shall obtain the City of Las Cruces and New Mexico State University approval of all traffic control plans that impacts public streets. When the project is phased, the traffic control plans shall clearly indicate the specific devices installed during each phase or construction.

D. All traffic control plans shall be submitted for review a minimum of three weeks prior to the erection of the devices.

E. All traffic control devices shall be subject to the Owner's review in the field. The Owner reserves the right to monitor the actual performance on the installed traffic control devices and require modifications to facilitate activities on and around the site. The Contractor shall modify

the traffic control plans and devices as directed by the Owner.

F. Do not close or obstruct streets, walks, bike lanes or access to facilities without the approval of the Owner. The Contractor shall request approval of all such closures a minimum of 72 hours prior to the scheduled closure. When streets, sidewalks, bike lanes or access is restricted, provide alternate routes (detours) around closed or obstructed traffic ways.

G. Signage for street, bike lane and sidewalk closure, detours, shall be equipped with a sub-panel that describes the work in progress and the appropriate detour. The specific wording on the sub-panel shall be reviewed as part of the traffic control plan submitted by the Contractor.

H. All placement of signage within landscape areas shall be coordinated and approved by .

I. To maintain pedestrian traffic around the site, and to adjacent facilities, the Contractor shall construct all required temporary sidewalks, and curb ramps. All temporary facilities shall be capable of supporting all loads, have a non-slip surface, and shall comply with ADA accessibility standards. Ramps shall not have any vertical lip greater than ¼-inch and a longitudinally slope of less than 1-foot vertical to 12-feet horizontal. The cross slope of temporary facilities shall not exceed 2 percent. The minimum width of pedestrian detours shall be 6-feet.

J. Barriers and traffic control devices shall be adequate for visually impaired pedestrians. Barricades and fencing shall be equipped with toe-kicks. Toe-kicks shall be a minimum of 3-inches in height and be installed the base of the barricade or fence at all locations where the fence or barricade crosses or runs parallel to a logical walkway.

K. The site and off-site excavations shall be enclosed within a six (6) foot high chain link fence. The fence shall restrict all unauthorized entrances into the work area and shall be anchored to the ground. The location of the fencing shall be approved by the Owner and shall be placed to minimize the disruption to pedestrian and vehicular traffic. During construction the Contractor shall monitor open gates to prevent unauthorized entrances into the work area. When work is not in process, all gates shall be closed and locked.

L. The Contractor shall provide flag personnel as required to guide construction vehicles into and out of the fenced construction area.

M. At the completion of the construction, all temporary detours, ramps, pavement, pavement markings, and signage shall be removed and the surfacing restored to its original condition.

N. The traffic control plans shall clearly indicate the construction haul routes to be utilized during construction.

O. When traffic control restricts the vehicular circulation within existing parking lots, the traffic control shall delineate with temporary pavement markings and signage all required temporary parking area access lanes to maintain adequate vehicular circulation.

3.10 PROTECTION OF EXISTING UTILITIES:

A. It shall be the responsibility of the Contractor to contact the New Mexico 811 and the New Mexico State University a minimum of seven working days prior to the commencement of any excavating operations. The Contractor shall record and maintain all utility locating markings

and coordinate any and all re-markings of the utilities that may be required.

B. The utilities locations indicated on the drawings were compiled based on the best available information. However, the utility locations are not considered to be exact or complete. Prior to commencing work, the Contractor shall verify the horizontal and vertical location of all utilities with the appropriate organization and. If necessary, pothole all utility lines whose exact horizontal or vertical location is in question.

C. It shall be the responsibility of the Contractor to protect all existing utilities "in-place" unless specifically noted otherwise in the contract documents. The Contractor shall install all temporary supports required to protect utilities and structures crossing, or adjacent to the excavations required to prevent their movement or settlement.. All temporary supports shall be capable of resisting all horizontal and vertical forces within, and acting on, the utility or structure.

D. Owner assumes no responsibility for actual condition of existing structures and utilities crossing, and/or adjacent to this project. It shall be the sole responsibility of the Contractor to protect all structures and utilities in place.

E. The Contractor shall prepare, and submit, details of the methods to be utilized to support utility lines crossing, and abutting, the trench or excavation. The detail shall clearly show the techniques that will be enacted to support the utility lines both horizontally and vertically.

F. Do not interrupt any utilities, except when authorized by the Owner. When required, provide temporary services during interruptions to existing utilities. The cost associated with temporary utilities shall be included in the bid price.

G. In the event that the Contractor damages an existing utility line, the Contractor shall immediately contact the New Mexico State University and the utility owner to report the incident.

H. The Contractor shall promptly repair the damaged utility to the satisfaction of the utility owner.

I. The repair of all damage to utility lines shall be subject to the specifications and inspection of the utility owner. The cost of all utility repairs shall be the sole responsibility of the Contractor.

3.11 WORK WITH THE PUBLIC RIGHT-OF-WAY:

A. All work within the public right-of-way shall be covered under an agreement between the University and the City of Las Cruces. All work covered by this agreement shall be subject to the inspection and acceptance by the City.

3.12 CONSTRUCTION WATER SUPPLY:

A. No University water supply is available on the site for construction water associated with earthworks and for flushing and testing of the chilled water system.

B. The Contractor shall arrange for a construction water service from The City of Albuquerque. The construction water service shall be equipped with all backflow prevention equipment required by the City of Albuquerque.

C. The Contractor shall be responsible for the cost of the construction water meter service and the

cost of all water used.

3.13 HISTORICAL PRESERVATION:

A. The Contractor shall protect all historical features adjacent to construction site. Historical features within this area of the campus include Historically significant buildings, landscapes, and places or objects that possess exceptional value of quality in representing and reflecting the architecture and cultural heritage of the University, and specimen species of trees.

3.14 MATERIAL TESTING SITE WORKS:

A. The Contractor shall be responsible for all material testing associated with material submittals and their approvals.

B. The Owner will engage a testing agency to perform material testing or the completed work or portions thereof. The Contractor shall provide the Owner with an adequate schedule to allow the Owner to coordinate all such testing. The Contractor shall provide adequate access to the site to the testing agency. The test conducted on behalf of the Owner shall not relieve the Contractor of any contractual obligation to construct the project in accordance with the contract documents. The Contractor may elect to perform additional testing at their sole expense. Copies of all additional testing shall be provided to the Owner.

B. All costs associated with the re-testing of materials that have failed prior testing shall be the sole responsibility of the Contractor.

C. The frequency and type of material testing shall be at the sole desecration of the Owner.

3.15 DOCUMENTATION OF EXISTING CONDITIONS:

A. Prior to the start of the construction, the contractor shall take photographs of the existing conditions of the area adjacent to the construction site. The photographs shall clearly show the existing conditions of the site and the areas adjacent to the site. Copies of the photographs shall be submitted to the Owner.

END OF SECTION 024100

SECTION 031100 - CONCRETE FORMWORK

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section includes formwork for cast-in-place concrete, including waterstops, and installation of embedded items.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Reinforcement - Section 03 20 00

B. Cast-In-Place Concrete - Section 03 30 00

1.03 QUALITY ASSURANCE

A. Comply with the American Concrete Institute Standard, ACI 347R-94, Recommended Practice for Concrete Formwork.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D 226-97a Standard Specification for Asphalt - Saturated Organic Felt used in Roofing and Waterproofing".

2. ASTM D 1751-83 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

PART 2 PRODUCTS

2.01 MATERIALS

A. Forms for Exposed Finish Concrete: Plywood complying with U.S. Product Standard PS-1-83 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better or metal, metal-framed plywood or other acceptable panel-type materials. Plywood shall be mill-oiled and edge-sealed, with each piece bearing legible inspection trademark. Furnish in largest practicable sizes to minimize number of joints. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.

B. Forms for Unexposed Finish Concrete: Use plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Forms for Round Piers or Columns: One-piece, disposable fiber forms or approved equal.

D. Void Forms: Wax treated fiber board, 4" height, designed to resist 1000 psf pressure.

E. Form Coatings: Commercial formulation that will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

F. Chamfer Strips: 3/4" by 3/4" wood, PVC, or rubber.

G. Preformed Construction Joint: 24 gage steel, galvanized, shaped to form a continuous tongue and groove key.

H. Preformed Control Joint: Rigid plastic or metal strip with removable top section.

I. Expansion Joint Material: Asphalt saturated fiberboard, 1/2" thick, meeting the requirements of ASTM D 1751.

J. Felt: Asphalt-saturated organic felt, weighing 30 pounds per 100 square feet, meeting the requirements of ASTM D 226.

K. Waterstops: PVC, meeting the requirements of CRD-C572. Provide 6" wide dumbbell shape waterstop with 3/16 inch minimum web thickness and 3/8 inch minimum end bulb diameter.

PART 3 EXECUTION

3.01 COORDINATION

A. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel. Set screeds accurately. Embedded items shall be accurately aligned and adequately supported. Verify installation of mechanical, plumbing, and electrical items to be embedded in concrete. Correct any unsatisfactory condition before proceeding further.

3.02 PREPARATION

A. Form Coating: Coat contact surfaces of forms with a form-coating compound before reinforcement is placed. Thin form-coating compounds with thinning agent and apply as specified in manufacturer's instructions. Do not allow excess form-coating material to accumulate in forms or to come into contact with concrete surfaces against which fresh concrete will be placed.

3.03 INSTALLATION

A. Formwork: Formwork shall support vertical and lateral loads that are applied until such loads can be supported by concrete structure. Formwork shall be readily removable

without impact, shock or damage to cast-in- place concrete surfaces and adjacent materials. Construct forms to sizes, shapes, lines and dimensions shown. Perform surveys to obtain accurate alignment. Provide for recesses, chamfers, blocking, anchorages, inserts, and other features required in work. Select materials to obtain required finishes. Butt joints solidly and provide backup at joints to prevent leakage of cement paste.

B. Chamfer Strips: Provide at exposed corners and edges.

C. Form Ties: Use factory fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete surfaces upon removal.

D. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris before concrete is placed. Retighten forms and bracing after concrete placement as required to eliminate mortar leaks and maintain proper alignment.

3.04 INSTALLATION OF EMBEDDED ITEMS

A. General: Set anchorage devices and other embedded items accurately. Use setting drawings, diagrams, templates and printed instructions provided by supplier. Secure embedded items such that they are not displaced during placement of concrete.

B. Waterstops: Install according to manufacturers printed instructions. Splice waterstop sections using square cut butt joints and fuse sections together with indirect heat from preheated splicing iron. Use of direct flame is prohibited.

3.05 JOINTS

A. Construction Joints: Locate and install construction joints, which are not shown on drawings, so as not to impair strength and appearance of the structure. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints unless noted otherwise.

B. Keyways: Provide keyways at least 1-1/2" deep in construction joints in walls and slabs.

C. Preformed Construction Joint For Slabs on Grade: Secure with galvanized steel stakes, 1/8" thick by 1-1/8 inches wide with 1/2" deep rib and tapered point. Splice adjoining joints with 24 gage steel, galvanized splice plates.

D. Isolation Joints in Slabs on Grade: Construct isolation joints in interior slabs using 30 lb. felt. Provide isolation joints at points of contact between slabs on grade and vertical surfaces, such as column pedestals, foundation walls, grade beams and elsewhere as indicated. Construct isolation joints on exterior slabs abutting vertical surfaces with 1/2" thick expansion joint material.

E. Control Joints in Slabs-on-Grade:

1. Preformed Strip: Insert premolded rigid plastic, or metal strip into fresh concrete. Cut groove for strip using 10 foot long straight edge cutting tool. Depths of strip shall be one fourth of slab thickness. Press strip into groove such that top of strip is level with the concrete surface. Pull off removable top section, if any, prior to troweling.

2. Saw Cut: Contractor may saw cut control joints instead of using preformed strips. Saw cut joints shall be 1/8 inch wide. Saw cut depth should equal 1/3 of slab depth. Cut joints after concrete has hardened sufficiently to prevent raveling; usually 4 to 12 hours after slab has been cast and finished. Use diamond or silicone-carbide blades.

F. Control Joints in Walls: Create weakened planes in cantilevered retaining walls at 25 feet on center. Use preformed strips, placed vertically, full height in each face of wall. Depth of strips shall be one inch.

3.06 REMOVAL OF FORMWORK

A. General: Prevent excessive deflection, distortion, and damage to concrete when forms are stripped. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.

B. Formwork and supports at sides of concrete shall remain in place for 24 hours after concrete placement. This period represents cumulative number of hours, not necessarily consecutive, during which the temperature of the air surrounding the concrete is above 50 degrees F. Formwork and shoring which support the weight of concrete shall not be removed until concrete has attained its specified compressive strength.

C. Ensure safety of the structure. Do not superimpose any load on concrete until forms are removed and concrete is cured.

3.07 RE-USE OF FORMS

A. General: Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are intended for successive concrete placement, thoroughly clean surfaces and remove fins and laitance. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces.

END OF SECTION 031100

SECTION 032100 - CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section includes fabrication and installation of deformed bar and welded wire fabric reinforcing steel.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Formwork - Section 03 11 00.

B. Cast In Place Concrete - Section 03 30 00.

1.03 QUALITY ASSURANCE

A. Reference Standards:

1. American Concrete Institute (ACI)

a.	ACI 301-96	Specifications for Structural Concrete for Buildings.
b.	ACI 315-92	Details and Detailing of Concrete Reinforcement.
c.	ACI 318-85	Building Code Requirements for Reinforced Concrete.

2. American Society for Testing and Materials (ASTM)

a.	ASTM A 82-95	Standard Specification for Steel Wire, Plain, For Concrete Reinforcement
b.	ASTM A 185-94	Standard Specification for Steel Welded Steel Wire Fabric, Plain, for Concrete Reinforcement
c.	ASTM A 615/ A 615M-95b	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

3. Concrete Reinforcing Steel Institute (CRSI).

a. Manual of Standard Practice - 1992 Edition.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings for reinforcing steel. Comply with ACI 315 requirements showing layout, bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of reinforcing steel. Shop Drawings shall not be made by reproduction of the Contract Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60. Stirrups and ties may be Grade 40.

B. Welded Wire Fabric: ASTM A 185, flat sheets.

C. Steel Wire: ASTM A 82, 16 gage.

D. Supports for Reinforcing Steel: Wire bar type and precast concrete block type meeting the requirements of CRSI Manual of Standard Practice.

E. Fibrous Reinforcing: 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials and specifically manufactured for use as concrete reinforcement at a minimum of 0.1% by volume for the control of cracking due to drying shrinkage and thermal expansion/contraction.

2.02 FABRICATION

A. Fabricate reinforcing steel in accordance with fabricating tolerances in ACI 315.

B. Do not fabricate reinforcing steel until shop drawings are approved.

PART 3 EXECUTION

3.01 PLACING BAR SUPPORTS

A. General: Provide bar supports meeting the requirements of CRSI Specification for Placing Bar Supports.

B. Slabs-on-grade: Use supports with sand plates or precast concrete blocks or horizontal runners where base material will not support chair legs.

3.02 PLACING REINFORCING STEEL

A. General: Comply with CRSI Code of Standard Practice for "Placing Reinforcing Bars".

B. Clean reinforcing steel of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Accurately position, support and secure reinforcing steel against displacement by formwork, construction, or concrete placement operations. Place reinforcing steel to

obtain minimum coverages. Arrange, space and securely tie bars and bar supports to hold reinforcing steel in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

D. Concrete Cover:

1. Concrete cast against and permanently exposed to earth ..... 3"

2. Concrete exposed to earth or weather:

Bars larger than No. 5 .... 2"
Bars No. 5 or smaller .....1 1/2"

3. Columns or piers .... 1 1/2"

E. Rebar Splices: Locate at points of minimum stress or as shown on contract drawings. Unless noted otherwise, provide lap splices 30 bar diameters or 18" minimum length.

F. Welded Wire Fabric Splices: Lap one complete wire spacing.

G. Corner Reinforcing: Provide corner bars of same size and spacing as horizontal reinforcing steel. Lap with horizontal reinforcing 30 bar diameters or 18" minimum length.

H. Reinforcing at Construction/Control Joints: Continue reinforcing steel through construction joints unless noted otherwise. Discontinue reinforcing steel 2 inches from preformed construction joints in slabs-on-grade. Cut alternate longitudinal bars at weakened plane control joints in walls.

I. Fibrous Reinforcing:

1. Add fibrous concrete reinforcement to concrete materials at the time concrete is batched in amounts in accord with approved submittals for each type of concrete required.

2. Mix concrete in strict accord with fiber reinforcement manufacturer's instructions and recommendations for uniform and complete distribution.

END OF SECTION 032000

SECTION 033000 - CAST IN PLACE CONCRETE

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers cast-in-place concrete including finishing, surface repair and curing.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Formwork - Section 03 11 00

B. Concrete Reinforcement - Section 03 21 00

1.03 QUALITY ASSURANCE

A. Reference Standards: Meet the requirements of the following codes, specifications and standards.

1. American Concrete Institute (ACI) Publications;

a. ACI 301-96 Specifications for Structural Concrete for Buildings.

b. ACI 306.1-90 Standard Specification for Cold Weather Concreting

c. ACI 318-95 Building Code Requirements for Reinforced Concrete.

2. American Society for Testing and Materials (ASTM);

a. ASTM C 31-91 Standard Practice for Making and Curing Concrete Test
C 31M-96 Specimens in the Field.

b. ASTM C 33-97 Standard Specification for Concrete Aggregates.

c. ASTM C 39-96 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

d. ASTM C 94-97 Standard Specification for Ready-Mixed Concrete.

e. ASTM C 131-96 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

f. ASTM C 136-96a Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

g. ASTM C 143-90a Standard Test Method for Slump of Hydraulic Cement

Concrete.

h. ASTM C 150-97 Standard Specification for Portland Cement.

i. ASTM C 171-97 Standard Specification for Sheet Materials for Curing Concrete.

j. ASTM C 172-97 Standard Practice for Sampling Freshly Mixed Concrete.

k. ASTM C 173-94a Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

l. ASTM C 231-97 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

m. ASTM C 260-95 Standard Specification for Air Entraining Admixtures for Concrete

n. ASTM C 309-97 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

o. ASTM C 330-92 Standard Specification for Lightweight Aggregates for Structural Concrete

p. ASTM C 494-92 Standard Specification for Chemical Admixtures for Concrete

q. ASTM C 618-97 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

r. ASTM D 2103-92 Standard Specification for Polyethylene Film and Sheeting

s. ASTM D 4318-95a Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and admixtures.

B. Concrete Mix Design:

1. Submit mix design in accordance with ACI-301, Section 4.

2. Submit with mix design results of laboratory tests performed within previous 6 months indicating aggregates from the proposed source comply with the requirements of ASTM C 33 or C 330 as applicable.

C. Test Reports: Submit copies of test reports for concrete compressive strength, air content, temperature and slump.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, low alkali. Use one brand of cement throughout project.

B. Normal Weight Aggregates: ASTM C 33. Provide aggregates from a single source for exposed concrete.

C. Water: Potable.

D. Air-Entraining Admixture: ASTM C 260.

E. Water Reducing Admixture: ASTM C 494.

F. Fly-Ash: ASTM C 618, Class F.

G. Moisture-Retaining Cover: Provide waterproof paper, polyethylene film, or polyethylene-coated burlap meeting the requirements of ASTM C 171.

H. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound meeting the requirements of ASTM C 309; Type 1-D with fugitive dye for interior concrete and foundations; Type 2, white pigmented, for exposed exterior concrete except exposed exterior Architectural concrete, use Type 1-D.

I. Granular base shall meet the following grading requirements when tested in accordance with ASTM C 136.

Sieve Size (Square Openings)	Percent Passing by Weight
1 inch	100
3/4 inch	70-100
No. 4	35-85
No. 200	0-10

The plasticity Index shall be no greater than 3 when tested in accordance with ASTM D 4318. The coarse aggregate shall have a percent wear of 50 or less when tested in accordance with ASTM C.

2.02 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial mixture or field experience methods as specified in ACI 301, Section 4. If trial mixture method is used, employ an independent testing facility, acceptable to Architect, for preparing and reporting proposed mix designs.

B. Submit written reports to Architect, or Engineer, of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been approved.

C. Refer to the General Structural Notes for concrete strengths.

D. Admixtures

1. Use air-entraining admixture in all concrete, except air entrainment may, be omitted from concrete to receive a steel trowel finish. The entrained air content for exterior concrete shall be 4 - 7 percent and for interior concrete the air content shall be 3 - 6 percent.

2. Use water reducing admixture conforming to ASTM C 494, Type A, in all concrete unless approved otherwise by the Structural Engineer.

3. Use high range water reducing admixture conforming to ASTM C 494, Type F, in all concrete slabs unless approved otherwise by the Structural Engineer.

4. All other admixtures shall have the written approval of the Architect or Structural Engineer.

5. Calcium chloride is not permitted.

6. All admixtures, except high range water reducers, shall be added to the concrete at the batch plant.

7. Concrete for slabs to receive a steel trowel or float finish shall not contain both fly ash and high range water reducer.

PART 3 EXECUTION

3.01 COORDINATION

A. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel. Set screeds accurately. Embedded items shall be accurately aligned and adequately supported. Verify installation of mechanical, plumbing, and electrical items to be embedded in concrete. Correct any unsatisfactory condition before proceeding further.

3.02 PREPARATION

A. Before placing concrete, clean and roughen surface of previously placed concrete. Clean reinforcing steel. Remove debris, providing clean-outs at bottom of forms when necessary. Moisten surfaces to receive concrete unless otherwise prepared. Remove excess water before placing concrete.

3.03 CONCRETE PLACEMENT

A. General: Comply with ACI 301.

B. Place concrete continuously in layers not deeper than 24 inches. Concrete shall not be placed against concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable to its final location to avoid segregation. Do not use vibrators to transport concrete.

C. Maintain reinforcing in proper position during concrete placement operations.

D. Consolidate concrete, immediately after placing, by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

E. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface. Do not disturb slab surfaces prior to beginning finishing operations.

F. Cold Weather Concreting: Protect concrete work from physical damage or reduced strength caused by frost, freezing or low temperatures. Comply with ACI 306.1.

G. Hot Weather Concreting: When hot weather conditions exist that would impair quality and strength of concrete, reduce delivery time of ready mix concrete, lower the temperature of materials, or add retarder to ensure that the concrete is plastic. Retempering with water is not allowed.

3.04 FINISH OF FORMED SURFACES

A. Rough Form Finish: Provide where formed concrete surfaces are not exposed to view. Tie holes and surface imperfections shall be repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

3.05 FINISH OF HORIZONTAL SURFACES

A. At tops of foundation walls and grade beams finish with a texture matching adjacent formed surfaces unless otherwise indicated.

3.06 SLAB FINISHES

A. Float Finish: Begin floating when surface water has disappeared and when concrete has stiffened sufficiently to permit operation of power-driven or hand floats. Consolidate surface

with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance not exceeding 1/4" in 10' when tested with a 10' straightedge.

B. Scratch Finish: Apply scratch finish to slab surfaces that are to receive floor topping. Roughen surface before final set, using stiff brushes, or brooms.

C. Trowel Finish: Apply trowel finish to all slab surfaces unless noted otherwise. After floating, begin first trowel finish using a power-driven or hand trowel. Finish concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge.

D. Broom Finish: Apply on exterior slabs, ramps, steps, and sidewalks. Immediately after concrete has received a float finish, draw a broom or burlap belt across the surface to give a coarse transverse scored texture.

3.07 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Continue curing for at least 7 days using one of the following methods.

B. Moisture-retaining Cover curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed. Repair any holes or tears in cover during curing period. All concrete slabs are to be cured with moisture retaining cover for the first 24 hours. After that time the Contractor has the option to continue the moisture retaining cover, or remove the cover and apply liquid membrane-forming curing compound.

C. Curing compound: Apply curing compound uniformly in accordance with manufacturer's printed instructions.

3.08 CONCRETE SURFACE REPAIRS

A. Patching Surface Imperfections: Remove loose material and patch surface imperfections and holes left by tierods with cement mortar. Surface imperfections include honeycomb, excessive air voids, sand streaking and cracks.

3.09 FOR EXPOSED-TO-VIEW SURFACES

A. Blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify

mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

3.10 FIELD QUALITY CONTROL

A. The Contractor shall coordinate the services of a qualified testing laboratory to perform tests and submit test reports.

B. Sampling Fresh Concrete: ASTM C 172.

C. Slump: ASTM C 143; one test for each set of compressive strength test specimens.

D. Air Content: ASTM C 173 or C 231 for each set of compressive strength test specimens.

E. Concrete Temperature: Test hourly when air temperature is 40 degrees F. and below, when 80 degrees F and above; and when compression test specimens are made.

F. Compression Test Specimen: ASTM C 31, one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field cure test specimens are required. Mold one set of standard cylinders for volume of concrete specified below or fraction thereof.

1.	Slabs on Grade or Metal Deck	30 cubic yards
2.	Footings and stem walls	50 cubic yards
3.	All other locations (unless noted otherwise)	30 cubic yards

G. Compressive Strength Tests: ASTM C 39; test 1 specimen at 7 days, 2 specimens at 28 days, and retain one specimen in reserve for later testing. Additional Tests: The testing laboratory will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure as directed by the Architect. The testing laboratory may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by the Architect or Engineer. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

END OF SECTION 033000

SECTION 054000 – LIGHTGAGE METAL FRAMING

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section includes all lightgage studs, joists and track, 20 gauge or heavier, including bridging, and related accessories as indicated on the Contract Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Structural Steel - Section 05 12 00

B. Steel Joists - Section 05 21 00

C. Drywall Studs - Section 09 26 0 0

1.03 QUALITY ASSURANCE

A. Reference Standards:

1. American Iron and Steel Institute (AISI) Design of Cold Formed Steel Structural Members, 1980.

2. American Welding Society of (AWS) D1.3, 1992 Structural Welding Code.

3. American Society of Testing and Materials (ASTM).

a.	ASTM A 570/ A 570M-95	Standard Specification for Steel, Sheet and Strip, Carbon, Hot Rolled, Structural Quality.
b.	ASTM A 611-94	Standard Specification for Steel, Sheet, Carbon, Cold Rolled, Structural Quality.
c.	ASTM A 653/ Coated A 653M-95	Standard Specification for Steel Sheet, Zinc- (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.04 SUBMITTALS

A. Submit manufacturer's product information and installation instructions for each item of lightgage framing. Submit shop drawings for all prefabricated lightgage systems.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect metal framing units from rusting and damage. Deliver to project site in manufacturer's unopened containers or bundles, fully identified with name, brand, type, and grade. Store off ground in a dry ventilated space or protect with suitable waterproof coverings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Metal Framing:

1. All 12, 14, and 16 gage steel studs and joists shall be formed from steel that meets the requirements of one of the following standards with a minimum yield strength of 50,000 psi:

   a. Painted Material - ASTM A 570, Grade 50.

   b. Galvanized Material - ASTM A 653 Grade 50.

2. All 18 and 20 gage steel studs and joists; all track, bridging and accessories shall be formed from steel that meets the requirements of one of the following with a minimum yield strength of 33,000 psi:

   a. Painted Material - ASTM A 611, Grade C.

   b. Galvanized Material - ASTM A 653.

B. Material Finishes: All stud and joist components shall be primed with paint meeting the performance requirements of TT-P-1636C, or shall be formed from steel having a G-60 galvanized coating or better.

2.02 FABRICATION

A. Framing components may be prefabricated into panels prior to erection. Prefabricated panels shall be square, with components attached to prevent racking. Handling and lifting of panels shall be done in a manner as to not cause distortion in any member.

B. All framing components shall be cut squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Members shall be held positively in place until properly fastened.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install metal framing systems in accordance with manufacturer's printed instructions and recommendations, unless otherwise indicated on Contract Drawings.

B. Install and align tracks accurately to layout at base and tops of studs. Secure tracks as indicated on Contract Drawings. Provide fasteners at corners and ends of tracks.

C. Install supplementary framing, blocking and bracing in metal framing system to support fixtures, equipment, etc. Comply with stud manufacturer's recommendations and industry standards, considering weight and loading of each item.

D. Secure studs to top and bottom tracks by welding at both inside and outside flanges unless noted otherwise.

E. Frame wall openings larger than 2'-0" square with double studs at each jamb of frame except where more than 2 are either shown or indicated in manufacturer's instructions. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full-height studs of wall. Secure stud system wall opening frame in manner indicated.

F. Install horizontal bridging in stud system, spaced (vertical distance) at no more than 4'-0" o.c. Weld at each intersection.

G. Touch-up shop-applied protective coatings damaged during handling and installation. Use compatible primer for prime coated surfaces; use galvanizing repair paint for galvanized surfaces.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 GENERAL

1.01 WORK INCLUDED:

A. Furnish and install all metal fabrications as shown on Drawings and as specified under this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. Cast In Place Concrete - Section 03 30 00

B. Structural Steel - Section 05 12 00

C. Finishes - Division 9

1.03 REFERENCES:

A. The references listed below are declared to be a part of these specifications, the same as if fully set forth, except as modified herein. Unless specifically stated otherwise, the edition or revision of each document in effect at the beginning of work on this project shall be used.

B. American Society for Testing and Materials (ASTM):
1. ASTM A6 - General Requirements of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use
2. ASTM A36 - Structural Steel
3. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc, Coated, Welded and Seamless
4. ASTM A108 - Steel Bars, Carbon, Cold-Finished, Standard Quality
5. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
6. ASTM A386 - Zinc-Coating (Hot-Dip) on Assembled Steel Products
7. ASTM A569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled, Sheet and Strip, Commercial Quality
8. ASTM A668 - Steel Forgings, Carbon and Alloy, for General Industrial Use

C. American Welding Society (AWS)
1. AWS D1.1 - Structural Welding Code - Steel
2. AWS D1.3 - Structural Welding Code - Sheet Steel

D. American Institute of Steel Construction (AISC)
1. Manual of Steel Construction (1989)

E. Steel Structures Painting Council (SSPC)
1. SSPC-SP2 - Hand Tool Cleaning
2. SSPC-SP6 - Commercial Blast Cleaning

1.04 DEFINITIONS:

A. Definitions in ASTM E985 for railing-related terms apply to this section.

1.05 QUALITY ASSURANCE:

A. Codes and Standards: Comply with the provisions of the latest edition or revision of the following codes, standards and specifications, except as otherwise shown and specified.
   1. AISC "Manual of Steel Construction – Allowable Stress Design"
   2. AISI "Specification for the Design of Cold-Formed Steel Structural Members".
   3. AWS D1.1, "Structural Welding Code - Steel" and D1.3 "Structural Welding Code - Sheet Steel".
   4. ASTM A6, "General Requirements for Delivery of Rolled Steel Plates, Sheet Piling and Bars for Structural Use".

B. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedures".

C. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. Allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the work.

D. Inserts and Anchorages:
   1. Furnish inserts and anchoring devices which must be set in concrete for the installation of miscellaneous metal work. Coordinate delivery with other work to avoid delay.
   2. See concrete section of these specifications for installation of inserts and anchorage devices.

E. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.06 SYSTEM PERFORMANCE REQUIREMENTS:

A. Structural Performance: Design, engineer, fabricate, and install the following metal fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each metal fabrication.

1.07 SUBMITTALS:

A. General: Comply with requirements of Section 01340.

B. Manufacturer's Data: Manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions for products to be used in the fabrication of miscellaneous metal work, including paint products. Indicate by transmittal that copy of instructions has been distributed to the installer.

C. Shop Drawings: Submit shop drawings for the fabrication and erection of all assemblies of miscellaneous metal work which are not completely shown by the manufacturer's data sheets. Include profile, elevations, sizes, connections, reinforcing and accessories at required for complete installation. Show welded connections using standard AWS welding symbols.

1.08 PROJECT CONDITIONS:

A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Deliver to site as required to avoid interruption of work.

B. Store on blocking under shelters with supports as necessary to avoid damage due to self-weight or superimposed loads.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Steel
1. Plates and Shapes: ASTM A36 unless otherwise shown. ASTM A572, grade 50 where shown.
2. Pipe: ASTM A53, type E or S, grade B, black or galvanized as shown.
3. Steel Bars and Bar-Size Shapes: ASTM A283, Grade D or ASTM A36.
4. Bolts, nuts, washers:
   a. Standard bolts: ASTM A307, grade A for general use, grade B for use at flanged joints of piping systems, plain or zinc coated as shown.
   b. Anchor bolts: Except as otherwise shown, L-shaped with minimum 3" hook, 8" embedment in concrete, 4" threaded projection, double nutted, ASTM A307 or A36, plain or zinc coated as shown.

B. Primer Paint:
1. For general use in shop and field: FS TT-P-31, brown
2. For touch-up of galvanized surfaces: FS TT-P-641
3. For aluminum to be in contact with steel: FS TT-P-645
4. For aluminum to be in contact with concrete: BuRec CTP-1

C. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

D. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A47, or cast steel, ASTM A27. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A153.

E. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for the metal alloy to be welded.

2.02 FABRICATION - GENERAL:

A. Use materials of size and thickness shown, or, if not shown, of required size and thickness to produce adequate strength and durability in the finished product for the intended use. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for the various components of work.

B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise shown. Form bent-metal corners without otherwise impairing the work.

C. Weld corners and seams continuously and in accordance with the recommendations of AWS. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

D. Form exposed connections with hairline joints which are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type shown or, if not shown, use Phillips flathead (countersunk) screws or bolts.

E. Provide for anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices as shown and as required to provide adequate support for intended use of the work.

F. Cut, reinforce, drill and tap miscellaneous metal work as may be required to receive finish hardware and similar items of work.

2.03 STEEL FABRICATION:

A. General:
1. Conform to following standards of the American Institute of Steel Construction (AISC):
   a. "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings."
   b. "Code of Standard Practice for Steel Buildings and Bridges," with following exceptions:
      1) Connections shall be as shown on the Drawings except as specifically and individually approved otherwise by the Architect.
2. Welding shall conform to the AWS D1.1 "Structural Welding Code Steel" and AWS D1.3 "Structural Welding Code - Sheet Steel" and shall be performed by welders currently certified in accordance with AWS certification procedures to perform the type of welding required.
3. Mill bearing surfaces to true plane.
4. Shop connections: Welded, unless otherwise shown.
5. Field connections: Provide bolts for all field connections except where shown otherwise on Drawings.

B. Shop Painting:
1. Paint all steel items which are not specified or shown to be galvanized except as specified below. Paint after fabrication is complete. Exception: If portions of assemblages will not be accessible to painting after fabrication, paint those portions before fabrication.
2. Remove oil and grease, dirt, rust, loose mill scale, and other foreign elements by "Commercial Blast Cleaning" in accordance with SSPC-SP6 or by "Hand Tool Cleaning" in accordance with SSPC-SP2 as required.
3. Apply one or more coats of primer paint of specified type in accordance with paint manufacturer's directions as required to achieve recommended coverage and coating thickness for items to be used in a corrosive environment. Use painting methods which will result in full coverage of joints, corners, edges and all exposed surfaces.

4. Omit shop prime coat from contact surfaces of connections, from surfaces to be field welded, from parts to be embedded in concrete, and other parts which will not be exposed to view or weather after construction is complete.

C. Galvanizing:
1. Galvanize after fabrication all steel members and assemblages which are shown or specified to be galvanized.
2. Galvanize each item as specified. If coating type and thickness is not specified, provide hot-dipped galvanized coating equivalent to a G90 coating as specified in ASTM A525.
3. Protection of dissimilar materials:
   a. Aluminum surfaces in contact with steel shall be given one coat of zinc chromate primer in accordance with FS TT-P-645.
   b. Aluminum surfaces in contact with concrete shall be given coat of alkali-resistant bituminous paint meeting requirements of BuRec Specification CTP-1 (coal tar paint).

2.04 MISCELLANEOUS METAL ITEMS:

A. General: Provide and install items listed below and shown on drawings together with anchorage, attachment and accessories necessary for a complete installation. Items listed are principal items only. See drawing details for items not specifically listed.

B. Nosings (none): Furnish and install as detailed on Architectural Drawings.

C. Steel Pipe Railings and Handrails (none):
1. General: Fabricate pipe railings and handrails to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.

2. Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.
   a. At tee and cross intersections, notch ends of intersecting members to fit contour of pipe to which end is joined and weld all around.
3. Form changes in direction of railing members as follows:
   a. By insertion of prefabricated elbow fittings.
   b. By radius bends of radius indicated.
   c. By mitering at elbow bends.
   d. By bending.
   e. By any method indicated above, applicable to change of direction involved.
4. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross-section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.
5. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
6. Close exposed ends of pipe by welding 3/16 inch thick steel plate in place or by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch or less.
7. Toe Boards: Where indicated, provide toe boards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated, or if not indicated, use 4 inches high x 1/8 inch steel plate welded to, and centered between, each railing post.

8. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.
    a. For railing posts set in concrete fabricate sleeves from steel pipe not less than 6 inches long and with an inside diameter not less than 1/2 inch greater than the outside diameter of post, with steel plate closure welded to bottom of sleeve.
    b. Provide friction fit, removable covers designed to keep sleeves clean and hold top edge of sleeve 1/2 inch below finished surface of concrete.

D. Aluminum Roof & Parapet Ship Access Stair, both sides of parapet with crossover platfrom.
1. Description: Aluminum fabricated ship stair to traverse roof parapet.
2. Height: See plans for Parapet height.
3. Material: Aluminum Alloy 6005-T5
4. 60 Degree pitch
5. Stringers: 5”x2” x 3/16” Aluminum Channel
6. Handrails: 1 ¼” schedule 40 pipe
7. Location: See plans
8. Quantity: 1
9. Meet or exceed OSHA 1910 Subpart D.

2.05 CONCRETE FILL AND REINFORCING MATERIALS:

A. Concrete Materials and Properties: Comply with requirements of Division 3 section "Concrete Work" for normal weight, ready-mix concrete with minimum 28-day compressive strength of 3000 psi, unless higher strengths indicated.

B. Nonslip Aggregate Finish: Factory-graded, packaged material containing fused aluminum oxide grits or crushed emery as abrasive aggregate; rust- proof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

C. Reinforcing Bars: ASTM A615, Grade 60, unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION:

A. Prior to beginning installation of metal fabrications, inspect field conditions under which work is to be done. If conditions are not satisfactory, do not begin work until unsatisfactory conditions have been corrected to the satisfaction of the Contractor and the Architect. Beginning of installation represents Contractor's acknowledgement and certification that all conditions are satisfactory.

B. Furnish setting drawings, diagrams, templates, instructions and directions for the installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to the project site.

C. Thoroughly clean all parts which will be in contact.

D. Paint with specified paint all surfaces of dissimilar metals and any surfaces of aluminum fabrications which will be embedded in concrete.

3.02 INSTALLATION - GENERAL:

A. Install metal fabrication plumb and level or on slope as shown in their correct positions within specified tolerances.

B. Design, provide, install and maintain all temporary handrails, kickplates and other items as required by OSHA and as necessary to provide a safe workplace.

C. Use light drifting as necessary to draw holes together. Drifting to enlarge unfair holes is not permitted. If necessary to enlarge holes to make connections, use twist drills.

D. Weld steel members in accordance with AWS D1.1. Provide certification that all welders are currently qualified in accordance with AWS procedures.

E. Anchor handrails, ladders and miscellaneous items securely to supporting work as shown on the Drawings. Where attachments are not shown, anchor items using appropriate anchors subject to approval by the Architect.

F. Grout under baseplates to provide full bearing area after framing or equipment has been plumbed, leveled and aligned. Place grout in accordance with the manufacturer's directions using the damp-pack method. Do not apply loads to structural framing until grout under baseplates has been placed and properly cured.

G. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, lag bolts, wood screws and other connectors as required.

H. Cutting, Fitting and Placement:
   1. Perform cutting, drilling and fitting required for the installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry, or similar construction.
   2. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up shop paint coat. Do not weld, cut or abrade surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

I. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made and methods used in correcting welding work.

3.03 INSTALLATION OF STEEL PIPE RAILINGS AND HANDRAILS (none):

A. Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:

1. Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's directions.
2. Nonshrink, nonmetallic grout or anchoring cement.
3. Cover anchorage joint with a round steel flange attached to post as follows:

A. Welded to post after placement of anchoring material.
   1. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8 inch build-up, sloped away from post. For installations exposed on exterior, or to flow of water, seal anchoring material to comply with grout manufacturer's directions.

B. Anchor rail ends into concrete and masonry with steel round flanges welded to rail ends and anchored into wall construction with lead expansion shields and bolts.
   1. Install removable railing sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.

C. Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 1-1/2 inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated, or if not indicated, at spacing required to support structural loads. Secure wall brackets and wall return fittings to building construction as follows:
   1. Use type of bracket with pre-drilled hole for exposed bolt anchorage.
   2. For concrete and solid masonry anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
   3. For steel framed gypsum board assemblies, fasten brackets directly to steel framing or concealed anchors using self-tapping screws of size and type required to support structural loads.

3.04 INSTALLATION OF WALL HANDRAILS (none):

A. Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.

B. Mount handrails only on gypsum board assemblies reinforced to receive anchors, and where the location of concealed anchor plates has been clearly marked for benefit of Installer.

3.05 FIELD PAINTING:

A. Apply one or more coats of the primer paint specified to cleaned surfaces of bolts, to new welds and to abrasions to shop coat after erection. Apply as many coats as necessary to achieve protection of the metal surfaces at least equal to that provided by the shop paint.

B. Apply finish paints and coatings as specified in Division 9 Sections of these specifications.

3.06 PROTECTION AND REPAIR OF WORK:

A. Take all measures necessary to protect the work during the life of the contract.

B. If any portion of the work is found to be defective or is damaged by the Contractor's operations after it has been installed, it shall be repaired by the Contractor at his expense as directed by and to the satisfaction of the Architect. If, in the opinion of the Architect, the work has been damaged to the extent that satisfactory repairs are not possible or if repairs

have been made which are not acceptable, the Contractor shall remove the damaged items and replace with new undamaged items.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Shear wall panels.
   2. Rooftop equipment bases and support curbs.
   3. Wood blocking, cants, and nailers.
   4. Wood furring and grounds.
   5. Wood sleepers.
   6. Plywood backing panels.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

D. OSB: Oriented strand board.

E. Timber: Lumber of 5 inches nominal (114 mm actual) size or greater in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Shear panels.
4. Power-driven fasteners.
5. Post-installed anchors.
6. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Wood products shall be certified as "FSC Pure" or "FSC Mixed Credit".

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all rough carpentry unless otherwise indicated**.**

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: All wood material shall be fire-retardant-treated materials, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664 and design value adjustment factors shall be calculated according to ASTM D6841.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by testing agency.

E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all rough carpentry unless otherwise indicated.

2.4 SHEAR WALL PANELS

A. Wood-Framed Shear Wall Panels: Prefabricated assembly consisting of wood perimeter framing, tie downs, and Exposure I, Structural I plywood or OSB sheathing.

B. Steel-Framed Shear Wall Panels: Prefabricated assembly consisting of cold-formed galvanized-steel panel, steel top and bottom plates, and wood studs.

C. Allowable design loads, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.5 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.

B. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
2. Hem-fir or hem-fir (north); Construction or No. 2 Commongrade; NLGA, WCLIB, or WWPA.
3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
4. Eastern softwoods; No. 2 Common grade; NeLMA.
5. Northern species; No. 2 Common grade; NLGA.
6. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.6 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) or 3/4-inch (19-mm), as indicated, nominal thickness.

2.7 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or A4).

2.8 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch (25-mm) nominal thickness, compressible to 1/32 inch (0.8 mm); selected from manufacturer's standard widths to suit width of sill members indicated.

B. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

D. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring,]nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

C. Install shear wall panels to comply with manufacturer's written instructions.

D. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

F. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal (38-mm actual) thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.

G. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

K. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally and vertically at 24 inches (610 mm) o.c.

C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) o.c.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for plywood backing panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.

1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. including list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated plywood.
2. Fire-retardant-treated plywood.
3. Air-barrier and water-resistant glass-mat gypsum sheathing.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.

1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing: an independent agency, qualified according to ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.2 WOOD PANEL PRODUCTS

A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat all plywood unless otherwise indicated.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

2.5 WALL SHEATHING

A. Plywood Sheathing: DOC PS 1, sheathing.

1. Span Rating: Not less than 16/0.
2. Nominal Thickness: Not less than 1/2 inch (13 mm).

B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1, Structural I sheathing.

1. Span Rating: Not less than 16/0.
2. Nominal Thickness: Not less than 1/2 inch (13 mm).

C. Paper-Surfaced Gypsum Sheathing: ASTM C1396/C1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.
   1. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.
   2. Edge and End Configuration Square.
   3. Size: 24 by 96 inches (610 by 2438 mm) for horizontal, 48 by 96 inches (1219 by 2438 mm) for vertical installation.

D. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
   1. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.
   2. Size: 48 by 96 inches (1219 by 2438 mm for vertical installation.

E. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.
   1. Thickness: 5/8 inch (15.9 mm) thick.
   2. Size: 48 by 96 inches (1219 by 2438 mm for vertical installation.
   3. Edges: Square.
   4. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
   5. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference when tested according to ASTM E2178.
   6. Vapor Permeance: Minimum 20 perms (580 ng/Pa x s x sq. m) when tested according to ASTM E96/E96M, Desiccant Method, Procedure A.
   7. Sheathing Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa) when tested according to ASTM E2357.
   8. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
   9. UV Resistance: Can be exposed to sunlight for **30** days according to manufacturer's written instructions.
   10. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

F. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C1278/C1278M, gypsum sheathing.
   1. Product: Subject to compliance with requirements, provide "Fiberock Sheathing with Aqua-Tough" by United States Gypsum Co.
   2. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.
   3. Size: 48 by 96 inches (1219 by 2438 mm).

G. Cementitious Backer Units: ASTM C1325, Type A.
   1. Thickness: As indicated.

H. Fiberboard Sheathing: ASTM C208, Type IV, Grade 1 (Regular) cellulosic fiberboard sheathing with square edges, 1/2 inch (13 mm) thick.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C1002.
2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C954.

G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Paper-Surfaced or Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."

B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

C. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

2.8 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with APA AFG-01 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

1. Do not use adhesives that contain urea formaldehyde.

B. VOC limits for installation of adhesives and glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood glues: 30 g/L

2. Contact Adhesive: 2.50 g/L

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

~~*H. LEED Requirements*~~
~~*1. Provide submittals as required by Section 01 8113 Supplemental Table:*~~
~~*a. Submittal Requirements for LEED v4 Environmental Quality Credit.*~~

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
1. Fasten gypsum sheathing to cold-formed metal framing with screws.
2. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
3. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

F. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing:

1. Install accessory materials according to sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.

    a. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
    b. Install transition strip on roofing membrane or base flashing, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.

2. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
3. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
4. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip or preformed silicone extrusion, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.

    a. Transition Strip: Roll firmly to enhance adhesion.
    b. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

5. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.
6. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
7. Seal top of through-wall flashings to sheathing with an additional 6-inch- (150-mm-) wide, transition strip.
8. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
9. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.3 CEMENTITIOUS BACKER UNIT INSTALLATION

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.4 FIBERBOARD SHEATHING INSTALLATION

A. Comply with ASTM C846 and with manufacturer's written instructions.

B. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow 1/8-inch (3-mm) open space between edges and ends of adjacent units. Stagger horizontal joints if any.

C. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

3.5 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing and Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
3. Termination mastic has been applied on cut edges.
4. Strips and transition strips have been firmly adhered to substrate.
5. Compatible materials have been used.
6. Transitions at changes in direction and structural support at gaps have been provided.
7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
8. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783 or ASTM E2357.

E. Air barriers will be considered defective if they do not pass tests and inspections.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

END OF SECTION 061600

SECTION 064023 – CUSTOM PLASTIC LAMINATE CASEWORK

PART 1 - GENERAL

1.1 SUMMARY OF THE WORK: Furnish delivered to jobsite, unloaded, set in place, leveled and scribed, the work of this Section as indicated on the drawings and as specified and required for a complete installation.

1.2 SECTION INCLUDES:

A. Custom casework: high pressure decorative laminate finish

B. Countertops: high pressure decorative laminate finish

C. Countertops: Composite countertops

D. Hardware customarily furnished by the casework manufacturer

E. Installation

1.3 RELATED SECTIONS

A. Rough Carpentry, Section 061000, wood blocking, and grounds within finished walls and above finished ceiling

B. Division 5, Metal Fabrications

C. Division 7, Joint Sealants

D. Division 10, Specialties

E. Division 11, Equipment

F. Division 12, Furnishings (Laboratory Casework)

G. Division 21-23, Mechanical Sections

H. Division 26-28, Electrical Sections

1.4 REFERENCES

A. Architectural Woodwork Institute, AWI Quality Standards, current edition

B. ANSI/BHMA A156.9 - Cabinet hardware

C. NEMA LD3 - High pressure decorative laminate

D. Particleboard – ANSI 208.1 (American National Standards Institute)

E. Softwood plywood – US Products Standards PS1

F. Hardboard – ANSI AHA 135.484 (American Hardboard Association)

G. PVA adhesive (polyvinyl acetate) white glue, Type II ASTM-D3110

H. Aliphatic adhesive (carpenter's glue) Type II

I. Solvent-based contact cement MMM-A-J1308

J. Forestry Council (FSC) Standards and Cerfication

1.5 SUBMITTALS

A. Submit as required in Section 01340.

B. SHOP DRAWINGS:

1. Prior to commencement of work under this section, submit copies as required in Section 013300.
2. Submit plans and elevations indicating materials, profiles, assembly methods, joint details, fastening methods, and schedule of finishes. Include hardware cut sheets and lock schedules.
3. Submit drawings with dimensions in units of feet and inches.

C. SAMPLES:

1. If required by the Architect, submit a selected manufacturer's current full range of colors and patterns identifying those colors and patterns with premium costs.
2. Submit one sample of each type of required hardware in specified finish.

3. Submit one set of samples showing the current full range of colors for 0.5mm and 3mm PVC edge banding for selection by the Architect.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with AWI Quality Standards, current addition.

B. Work in this Section shall comply with the specified Grade(s) or Work and Section(s) of the current edition of the Architectural Woodwork Institute Quality Standards.

C. Woodwork manufacturers shall be certified by the AWI Quality Certification Program as competent to perform the work specified.

D. Certification shall be evidenced through the application of AWI Quality Certification labels and/or the issuance of an AWI letter of certification for the

project. QCP Registration # 07.0783.

E. Contractors and their personnel engaged in the work of this section shall be able to demonstrate successful experience with work of comparable extent, complexity and quality to that shown and specified.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to job site in a timely manner to ensure uninterrupted progress. Deliver all products with protective covering to prevent damage. Promptly remove damaged materials from job site and make timely replacements.

B. Protect units from moisture damage according to AWI Quality Standards, Section 1700, Installation.

C. Environmental Limitations: Do not deliver or install wood work until building is enclosed, wet work is complete, and HVAC is operating and maintaining designed temperature and relative humidity levels for the remainder of the construction period.

1.8 COORDINATION

A. Coordinate work of this Section with other applicable trades.

B. Pre-cut rough-ins for plumbing, electrical and data wherever possible.

1.9 FIELD MEASUREMENTS

A. Where casework is indicated to be fitted to other construction, check actual dimensions of other construction by accurate field measurements before fabrication, and show recorded measurements on final shop drawings.

1.10 WARRANTY.

A. Provide a written warranty that all casework materials and workmanship will be free from defects for a period of one year from the date of Substantial Completion of the project. Any defective work is to be repaired or replaced at no cost to the Owner.

PART 2 PRODUCTS:

2.2 APPROVED MANUFACTURERS:

A. The following manufacturers are approved for use based upon their being current participants in the Quality Certification Program (QCP) of the Architectural Woodwork Institute (AWI). If other manufacturers are current participants in the QCP, they may submit for Prior Approval as approved manufacturers:

1. Albuquerque Cabinets, Inc.: 4800 Hawkins NE, Albuquerque, NM 87109.
2. Calmar Manufacturing Co. Inc (Tru-Bilt brand): Calmar, Iowa - Represented by Institutional Products, LLC 230 Cynthia Loop NW, Suite C, Albuquerque, NM 87114.
3. Casework Technologies, Ltd. Co.: 709 Haines Ave. NW., Albuquerque, NM 87102.
4. O.G.B. Architectural Millwork: 3711 Paseo Del Norte, Suite B, Albuquerque, NM 87113.
5. Tech Craft Co.: 8400 Washington St. NE, Albuquerque, NM 87113
6. TMI Systems Design Corporation: Dickinson, North Dakota. Represented by Construction Specialties Suppliers, 801 Ranchitos NW, Albuquerque, NM 87114.
7. Westmark Casework: Tacoma, Washington - Represented by A.C.I.E., 4800 Hawkins NE, Albuquerque, NM 87109.

B. Use manufacturers that are certified for chain of custody by an FSC-accredited certification body. Refer to http://info,fsc.org/certifcate for approved companies

2.2 SHEET MATERIALS

A. SOFTWOOD PLYWOOD: Graded in accordance with AWI Grade Custom.

B. WOOD PARTICLEBOARD AND/OR FIBERBOARD: Shall be Industrial Grade Medium Density, complying with current ANSI A208.1 9 (particle board) or ANSI A208.2 (fiberboard), and shall be a “45 lb” board.

C. WOOD FIBERBOARD FOR MOISTURE APPLICATIONS: Substrate for all countertops with sinks shall be 3/4” MEDEX NC as manufactured by SierraPine complying with ANSI A208.2-1994, “45 lb” board.

D. THERMOSET DECORATIVE OVERLAY: Particleboard or medium density fiberboard with surface of thermally fused, melamine–impregnated decorative paper complying with LMA SAT-1. Color: White.

E. COMPOSITE COUNTERTOPS: Where scheduled on the Architectural Casework Drawings, provide CaesarStone Quartz Surfacing distributed by U.S. Quartz Products Inc (CaesarStone U.S.A., Inc.); Van Nuys, CA; phone 818-394-6000; www.caesarstoneus.com - 93 percent crushed quartz aggregate combined with resins and pigments and fabricated into slabs using a vacuum vibro-compaction process, 3/4" thick.

F. COMPOSITE COUNTERTOPS: Where scheduled on the Architectural Casework Drawings, provide Corian® surfaces from the DuPont company, Cast, nonporous, filled polymer, not coated, laminated or of composite construction with through body colors meeting ANSI Z124.3 or ANSI Z124.6.

2.3 HIGH PRESSURE DECORATIVE LAMINATE

A. AVAILABLE MANUFACTURERS: Subject to compliance with requirements, manufacturers offering high pressure decorative laminate that may be incorporated into the

work include:

1. Formica Corporation www.formica.com
2. Wilsonart International www.wilsonart.com
3. Nevamar Company www.nevamar.com

2.4 LAMINATE COLORS AND PATTERNS

A. In the absence of a specified laminate pattern and/or color, furnish non-premium-priced decorative laminates from manufacturer's standard selections, maximum of four different colors and/or patterns per project, limited to one color/pattern for cabinet and one color/pattern for countertop per elevation. When specified, furnish multiple patterns, colors and/or specialty materials.

B. Colors will be selected by Owner. Contractor shall provide Owner with laminate color sample chain for review.

2.5 HARDWARE

A. Hinges: Provide hinges from one of the following listed Brands:

1. MEPLA – Model SSP 29, 125 deg. Slide on Hinge.
2. GRASS – Series 3803 series, 120 deg. Snap on hinge.
3. BLUM – 120 deg. Clip on hinge.

C. PULLS

1. Door and drawer pulls shall be 4 – inch brushed aluminum wire staple pulls.

D. LOCKS: Provide on all doors and drawers. Brand: TIMBERLINE Cam Lock, Model CB-080 through 199 series. Locks to have a Bezel. Strike plates used where appropriate.
Keying Requirements: All locks in a single room shall be keyed alike. Locks shall be keyed different from room to room. Provide 2 master keys.

E. LATCHES: EPCO Model number 1018-N. Use on inactive door opposite locks.

F. DRAWER SLIDES: Drawer slides for all standard drawers shall be regular extension epoxy coated steel modular system by one of the following:

1. BLUM METABOX; Drawer System 320 & 330 Series. Color, white.
2. GRASS ZARGON; Drawer System 6000 Series. Color, white.
3. MEPLA INTEGRA; Drawer System "Integra Top" Clip on.

Where shown in drawings, file drawers shall have full extension slides and standard file hangers with option for letter or legal size files.

G. MAP CABINET DRAWER SLIDES: Drawer slides for all map style cabinets shall be regular extension epoxy coated by one of the following.
1. BLUM 230E; 100 lb. Bottom Mount drawer slide with stay-close detents.
2. GRASS 6610; 100 lb. Bottom Mount drawer slide with stay-close detents.

3. MEPLA-AFIT AL 1700; Bottom Mount drawer slide.

H. CASEWORK SHELF SUPPORTS: Bainbridge Mfg, 5mm dual pin part #3220 or equal.

I. HORIZONTAL DIVIDER SUPPORTS: Hafele 5mm steel wire ("magic wire"). Furnish in size appropriate to shelf size.

K. COUNTERTOP WIRING GROMMETS: 2 1/2"diameter with covers. Color black unless otherwise noted.

PART 3 - EXECUTION

3.1 FABRICATION - CABINET COMPONENTS

A. GENERAL:

1. Comply with the AWI Quality Standards (latest edition) Custom Grade.
2. Reference Section 400-G-3, Identification of Parts, for the criteria of exposed and semi-exposed surfaces.
3. Cabinet width dimensions are not to exceed 32" for both wall cabinets and base cabinets. Sink base cabinets and Map drawer cabinets will be the only exceptions.
4. Office Cabinetry style shall be constructed per Section 400-G-7, A; Flush Overlay.
5. Classroom cabinetry style shall be constructed per Section 400-G-7, B; Reveal Overlay.

B. DRAWERS:

1. Drawer fronts shall be 3/4" thick particleboard overlaid with high-pressure plastic laminate on both faces. Edges are banded with 3mm PVC with outer edges 1/8" radius. PVC edge colors shall be chosen from the submitted range to compliment or match the face color.
2. Steel Drawer Systems: Drawer bottoms and backs shall be 3/4" thick thermo fused melamine. Color to match cabinet interior. Edges are banded with .5mm PVC color to match cabinet interior.
3. Built Drawer Boxes:
   a. Drawer sides, sub front and backs shall be 1/2" thick minimum thermofused melamine. Color to match cabinet interior. Edges are banded with .5mm PVC color to match cabinet interior.
   b. Drawer bottoms shall be 1/2" thick minimum thermofused melamine. Color to match cabinet interior. Sides are rabbeted to accept bottom and bottom is to be glued and screwed as well as supported by screws from the bottom mount slides.

C. DOORS: Doors shall be 3/4" thick particleboard overlaid with a high-pressure plastic laminate on both faces. Edges shall be banded 3mm PVC with outer edges 1/8" radius. PVC edge colors shall be from the selected range to either match or compliment the face color.

D. CABINET ENDS, TOPS & BOTTOMS:

1. All panels shall be constructed with 3/4" particleboard as the core material.

2. At Semi-exposed (see AWI standards for definition and locations) ends, tops or bottoms the particleboard shall be overlaid with thermofused melamine on the exterior face.
3. At Exposed (see AWI standards for definition and locations) ends, tops or bottoms, the particleboard shall be overlaid with a high pressure decorative laminate on exposed faces. The inside color shall match the cabinet interior with the face color to match exterior color. The front edges shall be banded with .5mm PVC in color as selected by the Architect from the colors submitted.
4. In cabinets with doors, the interior surfaces of the particleboard shall be overlaid with either high pressure laminate cabinet liner or thermofused melamine. The color shall match the melamine surfaced back color. The front edges shall be banded with .5mm PVC to match exposed face color or as selected by the Architect from the colors submitted.
5. In open cabinets (without doors), the interior surfaces of the particleboard shall be overlaid with high pressure decorative to match exposed exterior color. The front edges shall be banded with .5mm PVC to match exposed face color or as selected by the Architect from the colors submitted.
6. All end panels shall be drilled for adjustable shelf supports with .5mm diameter holes on 32mm (1 1/4") centers. For shelves up to and including 30" depth, two vertical sets of holes shall be provided at each end panel. For shelves over 30" deep, three vertical sets of holes shall be provided at each end panel.

E. FIXED AND ADJUSTABLE SHELVES:

1. Semi-exposed Shelves: Regardless of cabinet width, all shelves shall be 1" thick particleboard overlaid with thermofused melamine on top and bottom faces. Color to match cabinet interior.
2. Exposed Shelves: Regardless of cabinet width, all shelves shall be 1" particleboard overlaid with high pressure decorative laminate. Color to match exterior unless otherwise noted on the drawings.
3. All four edges of adjustable shelves and front edge of fixed shelves shall be banded with .5mm edge banding in color to match shelf color or as selected by the Architect from the colors submitted.

F. CABINET BACKS:

1. All semi-exposed cabinet backs shall be 3/4" thick minimum thermofused melamine. Color to match cabinet interior.
2. All exposed backs shall be 3/4" thick minimum particleboard overlaid with a high-pressure plastic laminate. Color to match exterior for exposed backs.
3. Provide removable backs for service access where shown on the project drawings.
4. All backs shall be full bound by all sides, tops and bottoms of the cabinet.

G. DIVIDERS AND PARTITIONS:

1. Vertical dividers and partitions shall be 3/4" particleboard overlaid with thermofused melamine on both faces when semi-exposed and high pressure decorative laminate for exposed surfaces. The exposed edges shall be banded with .5mm PVC to match the other case edges.
2. Fixed Horizontal Dividers: Where indicated on the drawings, dividers less than 6" apart and less than 12" wide shall be 1/4" tempered hardboard grooved into adjacent cabinet members. The edges shall be sanded and entire shelf clear sealed.

3. Adjustable Horizontal Dividers: Where indicated on the drawings, dividers shall be 3/4" particleboard overlaid with thermofused melamine on both faces when semi-exposed and high pressure decorative laminate for exposed surfaces. Dividers shall be grooved to accept steel "magic wire" supports. The exposed edges shall be banded with .5mm PVC to match the other case edges

H. CABINET TOE BASES:

1. Cabinet bases shall be 4" standard height made in continuous lengths to ensure straight, level and true line of casework. The standard core materials shall be 3/4" particleboard. In rooms with floor drains, the core material shall be "Medex" MDF board or equal.
2. Bases shall be unfinished and ready for scheduled base finish to be applied.

I. MAP (FLAT FILE) CABINETS:

1. Drawer slides shall be as required in hardware section 2.6.G.
2. Drawer sides, sub front and backs shall be 1/2" thick minimum thermofused melamine. Color shall match cabinet interior. Edges shall be banded with .5mm PVC color to match cabinet interior.
3. Drawer bottoms shall be 1/2" thick minimum thermofused melamine. Color shall match cabinet interior. Sides shall be rabbeted to accept bottom and bottom is to be glued and screwed as well as supported by screws from the bottom mount slides.
4. Map cabinets over 24" wide shall have 2 pulls per drawer face.
5. Provide a paper curl stop on each drawer box located at the top back of the drawer box. Stop shall be 4" wide by 1/4" thick melamine panel and shall be screw attached.
6. Mobile cabinets shall be finished on all exterior sides, back and top. Provide minimum of 4 casters adequate to support fully loaded weight with ease of transport over both carpet and tiled flooring surfaces.

3.2 FABRICATION - COUNTER TOPS

A. GENERAL:

1. Comply with the AWI Quality Standards (latest edition) Custom Grade. Reference Section 400C
2. Decorative laminate counter tops shall be PF42 NEMA grade laminate with .020" backing sheet bonded to 3/4" particleboard substrate. Adhesives shall be either Type II PVA or contact cement depending on the size of the materials and job conditions.
3. Decorative laminate color selections shall be as selected from manufacturer's non-premium-priced patterns and colors. Reference Part 2, Section 2.2 and 2.3 for manufacturer brands and color quantity requirements.
4. Counter top thickness shall be as noted in Section B. below.
5. Where tops and back splashes in which sinks occur, utilize an industrial grade particle board or fiberboard with a 24 hour thickness swell factor of 5% or less and a 24 hour water absorption factor of 10% or less.
6. Counter tops shall be furnished in the longest lengths possible. When joints are required, they shall be factory prepared with a minimum of three 1/4" joint bolts each. Joints shall be field assembled with waterproof sealant to ensure stable and rigid construction. Avoid joints within 24" of sinks or knee spaces.

B. COUNTERTOP OPTIONS:

1. 180 Degree Wrap Post Forming Decorative Laminate Counter Tops:
   a. Where called for on the drawings, overall counter top thickness shall be 1 1/4" with buildup added to the substrate. A 1/4" wide x 1/4" deep drip groove shall be cut in the underside of the top in from the leading edge of the counter top. Standard overhang from cabinet body along front shall be 1 1/2". Exposed end overhang shall be 1/2".
   b. Post-formed counter tops shall be PF42 NEMA grade laminate with .020" backing sheet bonded to 3/4" particleboard substrate. This laminate shall be heated and then wrapped around the substrate as designed.
   c. Back splashes shall be 3/4" thick and 4" high self edged, unless specified otherwise.
2. PVC Edged Decorative Laminate Counter Tops.
   a. Where called for on the drawings, overall counter top thickness shall be 1 1/4" with buildup added to the substrate. Standard overhang from cabinet body along front shall be 1 1/2". Exposed end overhang shall be 1/2".
   b. Front edge of counter tops shall have 3mm PVC edge banding. Edge colors shall be from a select range to either match or compliment the top color.
   c. Back splashes shall be 3/4" thick and 4" high edged with same 3mm PVC banding as front edge unless specified otherwise.

3.3 EXAMINATION

A. Verify adequacy of in wall backing and support framing.

B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work

C. Before installing architectural woodwork, examine shop fabricated work for completion and complete work as required, including back priming and removal of packing.

D. Condition building and woodwork to average prevailing humidity conditions in installation areas before installing.

3.4 INSTALLATION

A. Install work in accordance with AWI Quality Standards (latest edition) Section 1700. Grade Custom.

B. Set and secure materials and components in place, plumb and level. Shim as required with concealed shims.

C. Scribe work abutting other components or work. Refinish cut surfaces or repair damaged finish at cuts.

D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, strapping and blocking with countersunk, concealed fasteners with blind nailing where possible for a complete installation.

E. CABINETS: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated.

F. TOPS: Anchor securely to base units and other support systems as indicated. Caulk space between backsplash and wall with specified sealant.

3.5 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork where possible to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop applied finishes to restore damaged or soiled areas.

3.6 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to fabricator and installer that ensures that woodwork is without damage or deterioration at the time of Substantial Completion.

END OF SECTION - 064023

SECTION 06 6450 - FIBERGLASS REINFORCED PLASTIC PANELS * for cleanroom and lab application.

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fiberglass reinforced polyester panel system for adhesive mounting.

B. Moldings, adhesive, and joint sealants.

1.2 RELATED SECTIONS

A. Section 09 2900 – Gypsum Board Assemblies.

1.3 REFERENCES

A. ANSI/AHA A135.5 - Prefinished Hardboard Paneling; current edition.

B. ASTM D 256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; current edition.

C. ASTM D 523 - Standard Test Method for Specular Gloss; current edition.

D. ASTM D 570 - Standard Test Method for Water Absorption of Plastics;

E. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics; 1997 current edition.

F. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer; current edition.

G. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; current edition.

H. ASTM D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement; current edition.

I. ASTM D 968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive; current edition.

J. ASTM D 1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials; current edition.

K. ASTM D 1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes; current edition.

L. ASTM D 2486 - Standard Test Method for Scrub Resistance of Wall Paints; current edition.

M. ASTM D 2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor; current edition.

N. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; current edition.

1.4 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Adhesives

B. Selection Samples: For each finish specified, one complete set of color chips representing manufacturer's full range of available colors and patterns.

C. Maintenance Instructions: Deliver to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Life Science Products- Bio/ CR-7 Hygienic Panel, www.lspinc.com
B. Crane Composites, www.cranecomposites.com, Glasbord
C. Requests for substitutions will be considered in accordance with provisions of the Bidding Documents.

2.2 APPLICATIONS

A. Install panels in the following locations:
    1. Refer to finish plans
    2. At all rooms to receive FRP wall panels, install panels full height of wall unless otherwise noted.

2.3 PANEL SYSTEM

A. Plastic Panel System: Factory finished FRP panels, adhesive, caulk joints, sealant, and accessories acceptable for cleanroom and laboratory applications, non-porous, high density, and high chemical resistance with seamless installation.

B. Panels: FRP Panels; fiberglass reinforced polyester, USDA approved for incidental food contact.
    1. Fire Rating: Class A or Class C per ASTM E-84
    2. Surface Texture: smooth high-gloss OR pebbled.
    3. Thickness: .09”
    4. Width: 4’
    5. Height: 8’
    6. Color: As noted on drawings or selected by Architect from manufacturer's standard selection.
    7. Cleanroom characteristics: does not support mold or mildew growth, biological resistance rating of 0.
    8. Cleaning Characteristics: meets chemical resistance requirements ISO 2812-1 and achieves E or G rating.
    9. Hardness: ASTM D-785: 46 Barcol
    10. Flexural Mod ASTM D-790-07: 557,693
    11. Water Vapor Transmission ASTM E-96: less than .0001 perms
    12. Air Permeance: ASMT E-2178: .00001 @ 300 pa

C. Panel Trim, sealant and accessories: provide color sil color-matched caulk and polyurethane seam sealant. Do not use poly propylene pvc moldings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin instillation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Take panels out of cartons and allow to acclimatize to room conditions for at least 48 hours prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.

D. Protect existing surfaces from damage due to installation.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use the adhesives recommended by the panel manufacturer unless prohibited by local regulations; obtain manufacturer's approval of alternative adhesives. Apply adhesive per manufacturer’s recommendations.

C. Install continuous bead of silicone sealant in each joint and trim groove and between trim and adjacent construction, maintaining 1/8 inch (3mm) expansion space.

D. Avoid contaminant of panel faces with adhesives, solvents, or cleaners; clean as necessary and replace if not possible to repair original condition.

E. Protect installed products until completion of project.

F. Touch-up, repair or replace damaged products after Substantial Completion.

END OF SECTION 06 6450

SECTION 071113 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cold-applied, cut-back-asphalt dampproofing.
2. Cold-applied, emulsified-asphalt dampproofing.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for bituminous vapor retarders under slabs-on-grade.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. *LEED Requirements*

1. Refer to specification Section 01 8113 Part 1.5 for LEED product submittal requirements.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course auxiliary materials recommended in writing by manufacturer of primary materials.

2.2 PERFORMANCE REQUIREMENTS

A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.3 LEED Requirements

A. *Provide submittals as required by Section 01 8113 Supplemental Table:*
   1. *Submittal Requirements for LEED v4 Materials and Resources Credits.*
   2. *Submittal Requirements for LEED v4 Environmental Quality Credits.*

2.4 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D4586/D4586M, Type I, Class 1, fibered.

B. Brush and Spray Coats: ASTM D4479/D4479M, Type I, fibered or nonfibered.

2.5 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D1227, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D1227, Type II, Class 1.

C. Brush and Spray Coats: ASTM D1227, Type III, Class 1.

2.6 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D41/D41M.

C. Emulsified-Asphalt Primer: ASTM D1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

D. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.

E. Patching Compound: Epoxy or latex-modified repair mortar of type recommended in writing by dampproofing manufacturer.

F. Protection Course: ASTM D6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

1. Thickness: Nominal 1/4 inch (6 mm).
2. Adhesive: Rubber-based solvent type recommended in writing by waterproofing manufacturer for protection course type.

G. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on one side or both sides with plastic film, nominal thickness 1/4 inch (6 mm), with a compressive strength of not less than 8 psi (55 kPa) per ASTM D1621, and maximum water absorption by volume of 0.6 percent per ASTM C272/C272M.

H. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C578, Type X, 1/2 inch (13 mm) thick.

I. Protection Course: Smooth-surfaced roll roofing complying with ASTM D6380/D6380M, Class S, Type III.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for dampproofing application.

B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.

D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches (150 mm) over outside face of footing.

1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
2. Lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.

D. Where dampproofing interior face of above-grade, exterior concrete and masonry walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

E. *LEED Requirements*
1. Provide Submittal as required by Section 01 8113 Supplemental Table:
a. Submittal Requirements for LEED v4 Environmental Quality Credit
b. Submittal Requirements for LEED v4 Materials and Resources Credits.

3.4 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or primer and one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

3.5 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or primer and one trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m).

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Interior Face of Single-Wythe Exterior Masonry Walls: Where above grade and indicated to be furred and finished, apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.6 PROTECTION COURSE INSTALLATION

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
2. Install protection course on same day of dampproofing installation (while coating is tacky) to ensure adhesion.

3.7 PROTECTION

A. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where panels are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

B. Correct dampproofing that does not comply with requirements; repair substrates, and reapply dampproofing.

END OF SECTION 071113

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Polyisocyanurate foam plastic board.
2. Glass-fiber blanket.
3. Polystyrene perimeter foundation insulation
4. Smoke Fire Stop Safing Insulation

B. Related Requirements:
1. Section 061600 "Sheathing" for foam-plastic board sheathing installed directly over steel framing.
2. Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
3. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. *LEED Requirements:*
1. Refer to specification Section 01 8113 Part 1.5 for LEED product submittal requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 LEED Requirements

A. *Provide submittals as required by Section 01 8113 Supplemental Tables:*
1. Submittal Requirements for LEED v4 Materials and Resources Credits.
2. Submittal Requirements for LEED v4 Environmental Quality Credits.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD

A. Polyisocyanurate Board, Foil Faced : ASTM C1289, foil faced, Type I, Class 1 or 2.
1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

B. Polyisocyanurate Board, Glass-Fiber-Mat Faced: ASTM C1289, glass-fiber-mat faced, Type II, Class 2.
1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.3 GLASS-FIBER BLANKET

A. Low Emitting Materials: Provide materials and construction
identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Glass-Fiber Blanket, Unfaced: ASTM C665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.

C. Glass-Fiber Blanket, Polypropylene-Scrim-Kraft Faced: ASTM C665, Type II (nonreflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).

D. Glass-Fiber Blanket, Kraft Faced: ASTM C665, Type II (nonreflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).

E. Glass-Fiber Blanket, Reinforced-Foil Faced: ASTM C665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

F. Glass-Fiber Blanket, Foil Faced: ASTM C665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

2.4 PERIMETER INSULATION

A. Perimeter Foundation Insulation: Extruded polystyrene foam insulation type 4 rigid, closed cell type with integral high density skin with integral latex modified concrete facing. Basis of design STYROFOAM Brand SM Extruded Polystyrene Foam Insulation by Dow Chemical or equal.

2.5 SMOKE FIRE STOP

A. Foil faced Termafiber Firespan Safing Insulation by USG Fire Stop Systems or equal.

2.6 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
   1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
   2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
   1. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.
   2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
   1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
      a. Ceiling plenums.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch (25 mm) between face of insulation and substrate to which anchor is attached.

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.7 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
1. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit lets than 0.05 – ppm formaldehyde.

C. Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

E. *LEED Requirements*
1. Provide submittals as required by Section 01 8113 Supplemental Table:
a. Submittal Requirements for LEED v4 Environmental Quality Credit.
b. Submittal Requirements for LEED v4 Materials and Resources Credits.

3.3 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
5. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
6. For wood-framed construction, install blankets according to ASTM C1320 and as follows:

    a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

7. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.

    a. Exterior Walls: Set units with facing placed toward as indicated on Drawings.
    b. Interior Walls: Set units with facing placed as indicated on Drawings.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.6 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072419 - WATER-DRAINAGE EXTERIOR INSULATION SYSTEM (EIFS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. EIFS-clad drainage-wall assemblies that are field applied over substrate.
   2. Water-resistive barrier coatings.

1.3 DEFINITIONS

A. Definitions in ASTM E 2110 apply to Work of this Section.
B. EIFS: Exterior insulation and finish system(s).
C. IBC: International Building Code.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each EIFS component, trim, and accessory, including water-resistive barrier coatings.

B. Sustainable Design Submittals:

   1. Product Data: For adhesives, indicating VOC content.
   2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
   3. Product Data: For coatings, indicating VOC content.
   4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

   1. Include details for EIFS buildouts.
   2. Include details for parapet cap flashing.

D. Samples: For each exposed product and for each color and texture specified, 8 inches square in size.

E. Samples for Initial Selection: For each type of finish-coat color and texture indicated.
   1. Include similar Samples of exposed accessories involving color selection.

F. Samples for Verification: 24-inch-square panels for each type of finish-coat color and texture indicated, prepared using same tools and techniques intended for actual work, including custom trim, each profile, and an aesthetic reveal.

   1. Include exposed trim and accessory Samples to verify color selected.
   2. Include a typical control joint filled with sealant of color selected, as specified in Section 079200 "Joint Sealants."

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Manufacturer Certificates: Signed by EIFS manufacturer, certifying the following:
   1. EIFS complies with requirements.
   2. Substrates to which EIFS is indicated to be attached are acceptable to EIFS manufacturer.
   3. Accessory products installed with EIFS, including joint sealants, flashing, water-resistive barrier coatings, trim, whether or not furnished by EIFS manufacturer and whether or not specified in this Section, are acceptable to EIFS manufacturer.

C. Product Certificates: For cementitious materials and aggregates and for insulation and joint sealant, from manufacturer.

D. Product Test Reports: For each EIFS assembly and component, and for water-resistive barrier coatings, for tests performed by a qualified testing agency.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For EIFS to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An installer who is certified in writing by AWCI International as qualified to install Class PB EIFS using trained workers.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.

B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
   1. Stack insulation board flat and off the ground.
   2. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.
   1. Proceed with installation of adhesives or coatings only when ambient temperatures have remained, or are forecast to remain, above 40 deg F (4.4 deg C) for a minimum of 24

hours before, during, and after application. Do not apply EIFS adhesives or coatings during rainfall.

1.11 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of EIFS-clad drainage-wall assemblies that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Bond integrity and weathertightness.
      b. Deterioration of EIFS finishes and other EIFS materials beyond normal weathering.
   2. Warranty coverage includes the following components of EIFS-clad drainage-wall assemblies:
      a. EIFS finish, including base coats, finish coats, and reinforcing mesh.
      b. Insulation installed as part of EIFS including foam buildouts.
      c. Insulation adhesive and mechanical fasteners.
      d. EIFS accessories, including trim components and flashing.
      e. Water-resistive barrier coatings.
      f. EIFS drainage components.
   3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   1. Acrocrete; BASF Corp.
   2. BASF Corp. - Construction Chemicals.
   3. Corev America, Inc.
   4. Decoplast; manufactured by Greenmaker Industries.
   5. Dryvit Systems, Inc.
   6. Finestone; BASF Corp.
   7. H.B. Fuller Construction Products Inc. / TEC.
   8. Master Wall Inc.
   9. Omega Products International, Inc.
   10. Parex USA, Inc.
   11. Pleko LLC.
   12. Senergy; BASF Corp.
   13. Sto Corp.
   14. Stuc-O-Flex International, Inc.
   15. Total Wall, Inc.

B. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with EIFS components.

2.2 PERFORMANCE REQUIREMENTS

A. EIFS Performance: Comply with ASTM E 2568 and with the following:
   1. Weathertightness: Resistant to uncontrolled water penetration from exterior, with a means to drain water entering EIFS to the exterior.
   2. System Fire Performance: Fire-resistance rating of wall assembly.
   3. Structural Performance of Assembly and Components:
      a. Wind Loads: Uniform pressure as indicated on Drawings.
   4. Impact Performance: ASTM E 2568, High impact resistance.

5. Abrasion Resistance of Finish Coat: Sample consisting of 1-inch-thick EIFS mounted on 1/2-inch-thick gypsum board; cured for a minimum of 28 days and shows no cracking, checking, or loss of film integrity after exposure to 528 quarts of sand when tested according to ASTM D 968, Method A.
6. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch clean glass substrate; cured for 28 days and shows no growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274.
7. Drainage Efficiency: 90 percent average minimum when tested according to ASTM E 2273.

2.3 EIFS MATERIALS

A. Water-Resistive Barrier Coating: EIFS manufacturer's standard formulation and accessories for use as water-resistive barrier coating; compatible with substrate.
1. Water-Resistance: Comply with physical and performance criteria of ASTM E 2570/E 2570M.
2. VOC Content: 100 g/L or less.
3. Low-Emitting Materials: Coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Flexible-Membrane Flashing: Cold-applied, self-adhering, self-healing, rubberized-asphalt, and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.

C. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; specifically formulated to be applied to back side of insulation in a manner that creates open vertical channels designed to serve as an integral part of the water-drainage system of the EIFS-clad drainage-wall assembly; compatible with substrate; and complying with one of the following:
1. Job-mixed formulation of portland cement complying with ASTM C 150/C 150M, Type I, and polymer-based adhesive specified for base coat.
2. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.
3. Factory-mixed noncementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
4. Adhesives shall have a VOC content of 50 g/L or less.
5. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Drainage Mat: Three-dimensional, nonwoven, entangled filament, nylon or plastic mat designed to drain incidental moisture by gravity; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer, with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.

E. Molded, (Expanded) Rigid Cellular Polystyrene Board Insulation: Comply with ASTM E 2430/E 2430M, unless otherwise noted, and the following:
1. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, according to ASTM E 84.
2. Dimensions: Provide insulation boards of not more than 24 by 48 inches, with thickness indicated on Drawings.

3. Channeled Board Insulation: EIFS manufacturer's standard factory-fabricated profile with linear, vertical-drainage channels, slots, or waves on the back side of board.
4. Foam Buildouts: Provide with profiles and dimensions indicated on Drawings.

F. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multiend strands with retained mesh tensile strength of not less than 120 lbf/in. according to ASTM E 2098/E 2098M and the following:
1. Reinforcing Mesh for EIFS, General: Not less than weight required to comply with impact-performance level specified in "Performance Requirements" Article.
2. Strip-Reinforcing Mesh: Not less than as recommended by EIFS manufacturer.
3. Detail-Reinforcing Mesh: Not less than as recommended by EIFS manufacturer.
4. Corner-Reinforcing Mesh: Not less than as recommended by EIFS manufacturer.

G. Base Coat: EIFS manufacturer's standard mixture complying with one of the following:
1. Job-mixed formulation of portland cement complying with ASTM C 150/ C 150M, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
3. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
4. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.
5. Adhesives shall have a VOC content of 50 g/L or less.
6. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Water-Resistant Base Coat: EIFS manufacturer's standard water-resistant formulation complying with one of the following:
1. Job-mixed formulation of portland cement complying with ASTM C 150/C 150M, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
3. Adhesives shall have a VOC content of 50 g/L or less.
4. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

I. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners, consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; designed to resist Project's design loads; capable of pulling fastener head below surface of insulation board; and complying with the following:
1. For attachment to steel studs from 0.033 to 0.112 inch in thickness, provide steel drill screws complying with ASTM C 954.
2. For attachment to light-gage steel framing members not less than 0.0179 inch in thickness, provide steel drill screws complying with ASTM C 1002.
3. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C 1002, Type W.

4. For attachment to masonry and concrete substrates, provide sheathing dowel in form of a plastic wing-tipped fastener with thermal cap, sized to fit insulation thickness indicated and to penetrate substrate to depth required to secure anchorage.
5. For attachment to substrate, provide manufacturer's standard fasteners suitable for substrate.

J. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.

1. VOC Content: 100 g/L or less.
2. Low-Emitting Materials: Coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

K. Finish Coat: EIFS manufacturer's elastomeric coating complying with the following:

1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
2. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.
   a. Aggregate: Marble chips of size and color as selected by Architect from mfg full range.
3. Colors: As selected by Architect from manufacturer's full range.
4. Textures: As selected by Architect from manufacturer's full range.

L. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.

M. Water: Potable.

N. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard cell class for use intended, and ASTM C 1063.

1. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
2. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
3. Weep Screed/Track: Prefabricated, one-piece type for attachment behind insulation with perforated face leg and weep holes in track bottom, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg; designed to drain incidental moisture that gets into wall construction to the exterior at terminations of EIFS with drainage.
4. Expansion Joint: Closed-cell polyethylene backer rod and elastomeric sealant 3/4-inch-minimum.
5. Windowsill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.
6. Parapet Cap Flashing: Type for both flashing and covering parapet top, with design complying with ASTM C 1397 and ANSI/SPRI/FM 4435/ES-1.

2.4 MIXING

A. Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials, except as recommended by EIFS manufacturer.

Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roof edges, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where EIFS will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Begin coating application only after surfaces are dry.
2. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.

B. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind drainage plane of EIFS and deterioration of substrates.

C. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.
1. Concrete Substrates: Provide clean, dry, neutral-pH substrate for insulation installation. Verify suitability of substrate by performing bond and moisture tests recommended by EIFS manufacturer.

3.3 EIFS INSTALLATION, GENERAL

A. Comply with ASTM C 1397, ASTM E 2511, and EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

3.4 SUBSTRATE PROTECTION APPLICATION

A. Water-Resistive Barrier Coating: Apply over sheathing to provide a water-resistive barrier.
1. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.

B. Flexible-Membrane Flashing: Install over water-resistive barrier coating, applied and lapped to shed water; seal at openings, penetrations, and terminations. Prime substrates with flashing primer if required and install flashing.

3.5 TRIM INSTALLATION

A. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, and elsewhere as indicated. Coordinate with installation of insulation.
1. Weep Screed/Track: Use at bottom termination edges, at window and door heads, and at floor line expansion joints of water-drainage EIFS unless otherwise indicated.
2. Windowsill Flashing: Use at windows unless otherwise indicated.

3. Expansion Joint: Use where indicated on Drawings.
4. Casing Bead: Use at other locations.
5. Parapet Cap Flashing: Use where indicated on Drawings.

3.6 DRAINAGE MAT INSTALLATION

A. Drainage Mat: Apply wrinkle free, continuously, with edges overlapped and mechanically secured with fasteners over water-resistive barrier coating.

3.7 INSULATION INSTALLATION

A. Board Insulation: Adhesively and mechanically attach insulation to substrate in compliance with ASTM C 1397 and the following:
   1. Apply adhesive to insulation by notched-trowel method, with notches oriented vertically to produce drainage channels that remain functional after the insulation is adhered to substrate.
   2. Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of drainage mat with adhesive once insulation is adhered to drainage mat.
   3. Apply adhesive to ridges on back of channeled insulation by notched-trowel method in a manner that results in full adhesive contact over the entire surface of ridges, leaving channels free of adhesive once insulation is adhered to substrate.
   4. Press and slide insulation into place. Apply pressure over entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
   5. Allow adhered insulation to remain undisturbed for not less than 24 hours, before installing mechanical fasteners, beginning rasping and sanding insulation or applying base coat and reinforcing mesh.
   6. Mechanically attach insulation to substrate. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
      a. Steel Framing: 5/16 inch.
      b. Wood Framing: 1 inch.
      c. Concrete and Masonry: 1 inch.
   7. Apply insulation over substrates in courses with long edges of boards oriented horizontally.
   8. Begin first course of insulation from a level base line and work upward.
   9. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
   10. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints, so no piece of insulation is less than 12 inches wide or 6 inches high. Offset joints not less than 6 inches from corners of window and door openings and not less than 4 inches from aesthetic reveals.
      a. Adhesive Attachment: Offset joints of insulation not less than 6 inches from horizontal and 4 inches from vertical joints in sheathing.
      b. Mechanical Attachment: Offset joints of insulation from horizontal joints in sheathing.
   11. Apply channeled insulation, with drainage channels aligned vertically.
   12. Interlock ends at internal and external corners.
   13. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
   14. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.

15. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/16 inch from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch. Prevent airborne dispersal and immediately collect insulation raspings or sandings.
16. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch.
17. Install foam buildouts and attach to structural substrate by adhesive and mechanical fastening.
18. Interrupt insulation for expansion joints where indicated.
19. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
20. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between casing beads and between perimeter casing beads and adjoining surfaces of width indicated.
21. Before installing insulation and before applying field-applied reinforcing mesh, fully wrap board edges. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches over front and back face unless otherwise indicated on Drawings.
22. Treat exposed edges of insulation as follows:
    a. Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.
    b. Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
    c. At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.
23. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and water-resistive barrier coating.

B. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:
1. At expansion joints in substrates behind EIFS.
2. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.
3. At floor lines in multilevel wood-framed construction.
4. Where wall height or building shape changes.
5. Where EIFS manufacturer requires joints in long continuous elevations.

3.8 BASE-COAT APPLICATION

A. Water-Resistant Base Coat: Apply full-thickness coverage to exposed insulation and to exposed surfaces of sloped shapes window sills parapets foam build-outs and to other surfaces indicated on Drawings.

B. Base Coat: Apply full coverage to exposed insulation and foam build-outs with not less than 1/16-inch dry-coat thickness.

C. Reinforcing Mesh: Embed reinforcing mesh in wet base coat to produce wrinkle-free installation with mesh continuous at corners, overlapped not less than 2-1/2 inches or otherwise treated at joints to comply with ASTM C 1397. Do not lap reinforcing mesh within 8 inches of

corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are invisible.

D. Double-Layer Reinforcing-Mesh Application: Where indicated or required, apply second base coat and second layer of reinforcing mesh, overlapped not less than 2-1/2 inches or otherwise treated at joints to comply with ASTM C 1397 in same manner as first application. Do not apply until first base coat has cured.

E. Additional Reinforcing Mesh: Apply strip-reinforcing mesh around openings, extending 4 inches beyond perimeter. Apply additional 9-by-12-inch strip-reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch-wide, strip-reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches on each side of corners.
   1. At aesthetic reveals, apply strip-reinforcing mesh not less than 8 inches wide.
   2. Embed strip-reinforcing mesh in base coat before applying first layer of reinforcing mesh.

F. Foam Buildouts: Fully embed reinforcing mesh in base coat.

G. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application, except without reinforcing mesh. Do not apply until first base coat has cured.

3.9 FINISH-COAT APPLICATION

A. Primer: Apply over dry base coat.

B. Finish Coat: Apply full-thickness coverage over dry primed base coat, maintaining a wet edge at all times for uniform appearance, to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
   1. Embed aggregate in finish coat to produce a uniform applied-aggregate finish of color and texture matching approved sample.

C. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Water-resistive barrier coatings applied over sheathing.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. EIFS Tests and Inspections: According to ASTM E 2359/E 2359M.

D. EIFS will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 CLEANING AND PROTECTION

A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION 072419

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS, VAPOR IMPERMEABLE

PART 1 — GENERAL

1.01 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, apply to the work of this section.

1.02 SUMMARY

A. The work of this section includes, but is not limited to, the following:
   1. Materials and installation methods for fluid applied air and vapor barrier membrane system located in the non-accessible part of the wall.
   2. Materials and installation methods to bridge and seal air leakage pathways in roof and foundation junctions, window and door openings, control and expansion joints, masonry ties, piping and other penetrations through the wall assembly.

B. Related Sections: Other specification sections that directly relate to the works of this section include, but are not limited to, the following:
   1. Section 033000 – Cast-In-Place Concrete
   2. Section 042000 – Unit Masonry
   3. Section 092900 - Gypsum Sheathing
   4. Section 071113 – Bituminous Dampproofing
   5. Section 071326 – Self-Adhering Sheet Waterproofing
   6. Section 075423 – Thermoplastic Polyolefin (TPO) Roofing
   7. Section 076200 – Sheet Metal Flashing and Trim
   8. Section 079200 – Joint Sealants

1.03 PERFORMANCE REQUIREMENTS

A. Provide an air and vapor barrier system to perform as a continuous barrier to air infiltration/exfiltration and water vapor transmission and to act as a liquid water drainage plane flashed to discharge any incidental condensation or water penetration.

1.04 REFERENCES

A. The following standards and publications are applicable to the extent referenced in the text. The most recent version of these standards is implied unless otherwise stated.

B. American Society for Testing and Materials (ASTM)
   1. C 836 Standard Specification for High Solids, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
   2. D 412 Standard Test Methods for Rubber Properties in Tension
   3. D 903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds

4. D 1644 Test Methods for Non-volatile Content of Varnishes
5. D 1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
6. D 4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
7. D 3767 Standard Practice for Rubber - Measurements of Dimensions
8. E 96 Test Methods for Water Vapor Transmission of Materials
9. E 283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
10. E 2178 Standard Test Method for Air Permeance of Building Materials
11. E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and substrate preparation recommendations.

B. Shop drawings showing locations and extent of air and vapor barrier system including details for terminations flashings, penetrations, window and door openings and treatment of substrate joints and cracks.

C. Written documentation demonstrating installers qualifications under the "Quality Assurance" article including reference projects of a similar scope.

D. Samples: Submit representative samples of the following for approval:
   1. Fluid applied air barrier membrane
   2. Transition Membrane
   3. Through Wall Flashing

E. Warranty: Submit a sample warranty identifying the terms and conditions stated in Section 1.09.

F. Refer to specification Section 01 8113 Part 1.5 for LEED product submittal requirements.

1.06 QUALITY ASSURANCE

A. Manufacturer: Air and vapor barrier systems shall be manufactured and marketed by a firm with a minimum of 20 years experience in the production and sales of waterproofing and air barrier products. Manufacturers proposed for use, but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.

B. Installer: The installer shall demonstrate qualifications to perform the work of this Section by submitting the following:
   1. List of at least three (3) projects contracted within the past five (5) years of similar scope and complexity to this project carried out by the firm and site supervisor.
   2. Installer must show evidence of adequate equipment and trained field personnel to successfully complete the project in a timely manner.

C. Materials: Fluid applied air and vapor barrier material shall be two part synthetic rubber based systems free of solvents, isocyanates and bitumen. For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.

D. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include but not be limited to the following:

1. Review of submittals.
2. Review of surface preparation, minimum curing period and installation procedures.
3. Review of special details and flashings.
4. Sequence of construction, responsibilities and schedule for subsequent operations.
5. Review of mock-up requirements.
6. Review of inspection, testing, protection and repair procedures.

E. Mock-up:

1. Prior to installation of the air and vapor barrier system a field-constructed mock-up shall be provided under the provisions of Section [01340 – Shop Drawings, Product Data, Samples and Mock-ups] to verify details and tie-ins and to demonstrate the required quality of materials and installation.
2. Construct a typical exterior wall section, 8 feet long and 8 feet wide, incorporating back-up wall, cladding, window and doorframe and sill, insulation, flashing and any other critical junction (roof, foundation, etc).
3. Allow 24 hours for inspection and testing of mock-up before proceeding with air and vapor barrier work.
4. Mock-up may remain as part of the work.

F. Inspection and Testing: Cooperate and coordinate with the Owner's inspection and testing agency. Do not cover any installed air and vapor barrier membrane until it has been inspected, tested and approved.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.

B. Do not double-stack pallets of fluid applied membrane components on the job site. Provide cover on top and all sides, allowing for adequate ventilation.

C. Protect fluid-applied membrane components from freezing and extreme heat.

D. Sequence deliveries to avoid delays, but minimize on-site storage.

1.08 PROJECT CONDITIONS

A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive the air and vapor barrier membrane.

1.09 WARRANTY

A. Submit manufacturer's warranty that air and vapor barrier and accessories are free of defects at time of delivery and are manufactured to meet manufacturer's published physical properties and material specifications.

B. Warranty Period: Five years from date of completion of the air barrier membrane installation.

PART 2 PRODUCTS

2.01 GENERAL

For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.

A. Provide submittals as required by Section 01 8113 Supplemental Table:

1. *Submittal Requirements for LEED v4 Environmental Quality Credits*.

2.02 FLUID APPLIED MEMBRANES

A. Description: a two part, self-curing, synthetic rubber based material free of solvents, isocyanates and bitumen

B. Performance Requirements:

Property	Test Method	Typical Value
Color		Green
Cured Film Thickness	ASTM D 3767 Method A	60 mils (1.5 mm) nominal
Solids Content	ASTM D 1644	100%
Air Permeance at 75Pa (0.3 in. water) Differential Pressure	ASTM E 2178	<0.001 L/(s.m^2) (<0.0002 cfm/ft^2)
Assembly Air Permeance at 75Pa (0.3 in. water) Differential Pressure	ASTM E 2357	<0.004 L/s*m^2 (<0.0008 cfm/ft^2)
Water Vapor Permeance	ASTM E 96, Method BW	Less than 4.6 ng/Pa.s.m^2 (0.08 Perms)
Pull Adhesion to Concrete Block (CMU)	ASTM D 4541-02	0.24 N/mm² (35 psi)
Pull Adhesion to Glass Faced Wall Board	ASTM D 4541-02	0.12 N/mm² (18 psi)
Peel Adhesion to Concrete	ASTM D 903 Modified[1]	880 N/m (5 lb./in.)
Elongation	ASTM D 412	500% minimum
Pliability, 180° Bend over 25 mm (1 in.) Mandrel at -30°C (-23°F)	ASTM D 1970	Unaffected
Low Temperature Flexibility and Crack Bridging 3.2mm (1/8in.) crack cycling at –26°C (-15°F)	ASTM C836	Pass
Extensibility over 6.4mm (1/4in.) crack after heat aging	ASTM C836	Pass

Footnote:

1. *The membrane is applied to concrete and allowed to cure. Peel adhesion of the membrane is measured at a rate of 50 mm (2 in.) per minute with a peel angle of 90° at room temperature.*

C. Acceptable Materials:

Perm-A-Barrier ® Liquid from Grace Construction Products, 62 Whittemore Avenue, Cambridge, MA.

Or approved equal

2.03 TRANSITION MEMBRANE

A. Description: 36 mil (0.9 mm) of self-adhesive rubberized asphalt integrally bonded to 4 mil (0.1 mm)of cross-laminated, high-density polyethylene film to provide a min. 40 mil (0.1 mm) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Performance Requirements:

1. Water Vapor Transmission: ASTM E 96, Method B: 2.9 ng/m2sPa (0.05 perms) max.
2. Air Permeance at 75Pa (0.3 in. water) pressure difference: 0.0006 L/(s.m^2) (0.00012 cfm/ft^2) max.
3. Puncture Resistance, ASTM E 154: 178 N (40 lbs.) min.
4. Lap Adhesion at –4°C (25°F), ASTM D 1876: 880 N/m (5.0 lbs./in.) of width
5. Low Temperature Flexibility, ASTM D 1970: Unaffected to –43°C (-45°F).
6. Tensile Strength, ASTM D 412, Die C Modified: min. 2.7 MPa (400 psi)
7. Elongation, Ultimate Failure of Rubberized Asphalt, ASTM D 412 Die C: min. 200%

C. Acceptable Materials:
Perm-A-Barrier Detail Membrane manufactured by Grace Construction Products.

2.04 TRANSITION ALUMINUM MEMBRANE

A. Description: 35 mil (0.9 mm) of self-adhesive rubberized asphalt integrally bonded to 5 mil (0.1 mm)of aluminum film to provide a min. 40 mil (1.0 mm) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Performance Requirements:

1. Water Absorption, ASTM D570: max 0.1% by weight
2. Puncture Resistance, ASTM E154: 355N (80 lbs) min.
3. Lap Adhesion at -4ºC (25ºF), ASTM D1876 Modified: 880 N/m (5.0 lbs./in.) of width
4. Low Temperature Flexibility, ASTM D1970 Modified: Unaffected to -26ºC (-15ºF)
5. Tensile Strength, ASTM D412, Die C Modified: min. 4.1 MPa (600 Psi)

6. Elongation, Ultimate Failure of Rubberized Asphalt, ASTM D412, Die C Modified: min. 200%

C. Acceptable Materials:

Perm-A-Barrier Aluminum Flashing manufactured by Grace Construction Products.

2.05 FLEXIBLE MEMBRANE THROUGH-WALL FLASHING

A. Description: 32 mil (0.8 mm)of self-adhesive rubberized asphalt integrally bonded to 8 mil (0.2 mm) of cross-laminated, high-density polyethylene film to provide a min. 40 mil (1.0 mm) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Performance Requirements:

1. Water Vapor Transmission, ASTM E 96, Method B: 2.9 ng/m2sPa (0.05 perms) max.
2. Water Absorption, ASTM D 570: max. 0.1% by weight
3. Puncture Resistance, ASTM E 154: 356 N (80 lbs.) min.
4. Tear Resistance
    a. Initiation, ASTM D 1004: min. 58 N (13.0 lbs.) M.D.
    b. Propagation, ASTM D 1938: min. 40 N (9.0 lbs.) M.D.
5. Lap Adhesion at -4ºC (25ºF), ASTM D 1876: 880 N/m (5.0 lbs./in.) of width
6. Low Temperature Flexibility, ASTM D 1970: Unaffected to -43ºC (-45ºF)
7. Tensile Strength, ASTM D 412, Die C Modified: min. 5.5 MPa (800 psi)
8. Elongation, Ultimate Failure of Rubberized Asphalt, ASTM D412, Die C: min. 200%

C. Acceptable Materials:

Perm-A-Barrier Wall Flashing manufactured by Grace Construction Products.

[Spec. Note: Perm-A-Barrier Aluminum Flashing is not to be used when materials that could cause corrosion of aluminum, such as stucco, are to be in direct contact with the aluminum facing of the Perm-A-Barrier Aluminum Flashing]

2.06 AIR & VAPOR BARRIER ACCESSORIES

A. Description: Water-based primer which imparts an aggressive, high tack finish on the treated substrate

1. Flash Point: No flash to boiling point
2. Solvent Type: Water
3. VOC Content: Not to exceed 10 g/l
4. Application Temperature: -4°C (25°F) and above
5. Freezing point (as packaged): -7°C (21°F)

Product: Perm-A-Barrier WB Primer manufactured by Grace Construction Products.

B. Description: Two part, elastomeric, trowel grade material designed for use with self-adhered membranes and tapes. 10 g/l max. VOC Content.

Product: Bituthene® Liquid Membrane manufactured by Grace Construction Products.

C. Optional Primers:

1. Description : Water-based primer which imparts an aggressive, high tack finish on the treated substrate. 1 g/l max. VOC Content.

Product : Perm-A-Barrier Primer Plus manufactured by Grace Construction Products.

2. Description: High tack water based primer. 10 g/l max. VOC content.

Product: Perm-A-Barrier Liquid Part B manufactured by Grace Construction Products.

PART 3 EXECUTION

3.01 EXAMINATION

A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Refer to manufacturer's literature for requirements for preparation of substrates. Surfaces shall be sound and free of voids, spalled areas, lose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods that are acceptable to manufacturer of the fluid-applied waterproofing.

B. Exterior sheathing panels: Ensure that the boards are sufficiently stabilized with corners and edges fastened with appropriate screws. Pre-treat all board joints with 50 - 75mm (2-3 in.) wide, reinforced self-adhesive tape or fiberglass mesh style wallboard tape. Gaps greater than 6mm (1/4 in.) should be filled with mastic or caulk, allowing sufficient time to fully cure before application of the tape and fluid applied membrane.

C. Masonry Substrates: Apply air and vapor barrier over concrete block and brick with smooth flush mortar joints. Fill all voids and holes, particularly in the mortar joints, with a lean mortar mix, non-shrinking grout or parge coat.

D. Related Materials: Treat construction joints and install flashing as recommended by manufacturer.

3.03 INSTALLATION

A. Refer to manufacturer's literature for recommendations on installation

B. Application of Fluid Applied Membrane

1. Spray or trowel apply a continuous uniform film at min. 60 mil (1.5 mm or .060 in.) dry film thickness using multiple, overlapping passes.

2. When spraying use a cross-hatching technique (alternating horizontal and vertical passes) to ensure even thickness and coverage.

3. When spraying use high pressure, multi-component, airless spray equipment approved by material manufacturer.
4. Carry membrane into any openings a minimum of 50mm (2 in.).
5. Seal all brick-ties and other penetrations as work progresses.

C. Application of Transition Membrane
1. After allowing the Fluid Applied Membrane to cure to tack-free, apply transition membrane with a minimum overlap of 75mm (3 in.) onto each surface at all beams, columns and joints as indicated in detail drawings.
2. Tie in to window and door frames, spandrel panels, roof and floor intersections and changes in substrate.
3. Use pre-cut, easily handled lengths for each location.
4. Remove silicone-coated release paper and position membrane flashing carefully before placing it against the surface.
5. When properly positioned, place against surface by pressing firmly into place by hand roller.
6. Overlap adjacent pieces 50 mm (2 in.) and roll all seams with a hand roller.
7. Seal top edge of flashing with termination mastic.
8. When transition flashing is pre-installed prior to application of Fluid Applied Membrane, apply transition flashing as above. Spray or trowel a continuous uniform film of Fluid Membrane at min. 60 mil (1.5 mm or .060 in.) dry film thickness using multiple, overlapping passes, with a minimum overlap of 75 mm (3 in.) onto transition flashing. For sill condition, spray or trowel Fluid Membrane onto pre-installed sill flashing and onto horizontal section of sill.

D. Application of Flexible Membrane Wall Flashing
1. Precut pieces of flashing to easily handled lengths for each location.
2. Remove silicone-coated release paper and position flashing carefully before placing it against the surface.
3. When properly positioned, place against surface by pressing firmly into place by hand roller. Fully adhere flashing to substrate to prevent water from migrating under flashing.
4. Overlap adjacent pieces 50 mm (2 in.) and roll all seams with a hand roller.
5. Trim bottom edge 13 mm (1/2 in.) back from exposed face of the wall. Flashing shall not be permanently exposed to sunlight.
6. At heads, sills and all flashing terminations, turn up ends a minimum of 50 mm (2 in.) and make careful folds to form an end dam, with the seams sealed.
7. Seal top edge of flashing with termination mastic.
8. Do not allow the rubberized asphalt surface of the flashing membrane to come in contact with poly-sulfide sealants, creosote, uncured coal tar products or EPDM.

E. LEED Requirements
1. Provide submittals as required by Section 01 8113 Supplemental Table:
a. Submittal Requirements for LEED v4 Environmental Quality Credits

3.06 PROTECTION AND CLEANING

A. Remove any masking materials after installation. Clean any stains on materials that would be exposed in the completed work using procedures as recommended by manufacturer.

B. Perm-A-Barrier Liquid is not suitable for permanent exposure and should be protected from the effects of sunlight.

C. Schedule work to ensure that the Perm-A-Barrier Liquid system is covered as soon as possible after installation. Protect Perm-A-Barrier Liquid system from damage during subsequent operations. If the Perm-A-Barrier Liquid system cannot be covered within 60 days after installation, apply temporary UV protection such as dark plastic sheet or tarpaulins.

END OF SECTION

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS, VAPOR IMPERMEABLE

PART 1 — GENERAL

1.01 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, apply to the work of this section.

1.02 SUMMARY

A. The work of this section includes, but is not limited to, the following:
   1. Materials and installation methods for fluid applied air and vapor barrier membrane system located in the non-accessible part of the wall.
   2. Materials and installation methods to bridge and seal air leakage pathways in roof and foundation junctions, window and door openings, control and expansion joints, masonry ties, piping and other penetrations through the wall assembly.

B. Related Sections: Other specification sections that directly relate to the works of this section include, but are not limited to, the following:
   1. Section 033000 – Cast-In-Place Concrete
   2. Section 042000 – Unit Masonry
   3. Section 092900 - Gypsum Sheathing
   4. Section 071113 – Bituminous Dampproofing
   5. Section 071326 – Self-Adhering Sheet Waterproofing
   6. Section 075423 – Thermoplastic Polyolefin (TPO) Roofing
   7. Section 076200 – Sheet Metal Flashing and Trim
   8. Section 079200 – Joint Sealants

1.03 PERFORMANCE REQUIREMENTS

A. Provide an air and vapor barrier system to perform as a continuous barrier to air infiltration/exfiltration and water vapor transmission and to act as a liquid water drainage plane flashed to discharge any incidental condensation or water penetration.

1.04 REFERENCES

A. The following standards and publications are applicable to the extent referenced in the text. The most recent version of these standards is implied unless otherwise stated.

B. American Society for Testing and Materials (ASTM)
   1. C 836 Standard Specification for High Solids, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
   2. D 412 Standard Test Methods for Rubber Properties in Tension
   3. D 903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds

4. D 1644 Test Methods for Non-volatile Content of Varnishes
5. D 1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
6. D 4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
7. D 3767 Standard Practice for Rubber - Measurements of Dimensions
8. E 96 Test Methods for Water Vapor Transmission of Materials
9. E 283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
10. E 2178 Standard Test Method for Air Permeance of Building Materials
11. E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and substrate preparation recommendations.

B. Shop drawings showing locations and extent of air and vapor barrier system including details for terminations flashings, penetrations, window and door openings and treatment of substrate joints and cracks.

C. Written documentation demonstrating installers qualifications under the "Quality Assurance" article including reference projects of a similar scope.

D. Samples: Submit representative samples of the following for approval:
   1. Fluid applied air barrier membrane
   2. Transition Membrane
   3. Through Wall Flashing

E. Warranty: Submit a sample warranty identifying the terms and conditions stated in Section 1.09.

1.06 QUALITY ASSURANCE

A. Manufacturer: Air and vapor barrier systems shall be manufactured and marketed by a firm with a minimum of 20 years experience in the production and sales of waterproofing and air barrier products. Manufacturers proposed for use, but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.

B. Installer: The installer shall demonstrate qualifications to perform the work of this Section by submitting the following:
   1. List of at least three (3) projects contracted within the past five (5) years of similar scope and complexity to this project carried out by the firm and site supervisor.
   2. Installer must show evidence of adequate equipment and trained field personnel to successfully complete the project in a timely manner.

C. Materials: Fluid applied air and vapor barrier material shall be two part synthetic rubber based systems free of solvents, isocyanates and bitumen. For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.

D. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include but not be limited to the following:

1. Review of submittals.
2. Review of surface preparation, minimum curing period and installation procedures.
3. Review of special details and flashings.
4. Sequence of construction, responsibilities and schedule for subsequent operations.
5. Review of mock-up requirements.
6. Review of inspection, testing, protection and repair procedures.

E. Mock-up:

1. Prior to installation of the air and vapor barrier system a field-constructed mock-up shall be provided under the provisions of Section [01340 – Shop Drawings, Product Data, Samples and Mock-ups] to verify details and tie-ins and to demonstrate the required quality of materials and installation.
2. Construct a typical exterior wall section, 8 feet long and 8 feet wide, incorporating back-up wall, cladding, window and doorframe and sill, insulation, flashing and any other critical junction (roof, foundation, etc).
3. Allow 24 hours for inspection and testing of mock-up before proceeding with air and vapor barrier work.
4. Mock-up may remain as part of the work.

F. Inspection and Testing: Cooperate and coordinate with the Owner's inspection and testing agency. Do not cover any installed air and vapor barrier membrane until it has been inspected, tested and approved.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.

B. Do not double-stack pallets of fluid applied membrane components on the job site. Provide cover on top and all sides, allowing for adequate ventilation.

C. Protect fluid-applied membrane components from freezing and extreme heat.

D. Sequence deliveries to avoid delays, but minimize on-site storage.

1.08 PROJECT CONDITIONS

A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive the air and vapor barrier membrane.

1.09 WARRANTY

A. Submit manufacturer's warranty that air and vapor barrier and accessories are free of defects at time of delivery and are manufactured to meet manufacturer's published physical properties and material specifications.

B. Warranty Period: Five years from date of completion of the air barrier membrane installation.

PART 2 PRODUCTS

2.01 GENERAL

For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.

2.02 FLUID APPLIED MEMBRANES

A. Description: a two part, self-curing, synthetic rubber based material free of solvents, isocyanates and bitumen

B. Performance Requirements:

Property	Test Method	Typical Value
Color		Green
Cured Film Thickness	ASTM D 3767 Method A	60 mils (1.5 mm) nominal
Solids Content	ASTM D 1644	100%
Air Permeance at 75Pa (0.3 in. water) Differential Pressure	ASTM E 2178	<0.001 L/(s.m^2) (<0.0002 cfm/ft^2)
Assembly Air Permeance at 75Pa (0.3 in. water) Differential Pressure	ASTM E 2357	<0.004 L/s*m^2 (<0.0008 cfm/ft^2)
Water Vapor Permeance	ASTM E 96, Method BW	Less than 4.6 ng/Pa.s.m^2 (0.08 Perms)
Pull Adhesion to Concrete Block (CMU)	ASTM D 4541-02	0.24 N/mm² (35 psi)
Pull Adhesion to Glass Faced Wall Board	ASTM D 4541-02	0.12 N/mm² (18 psi)
Peel Adhesion to Concrete	ASTM D 903 Modified[1]	880 N/m (5 lb./in.)
Elongation	ASTM D 412	500% minimum
Pliability, 180° Bend over 25 mm (1 in.) Mandrel at -30°C (-23°F)	ASTM D 1970	Unaffected
Low Temperature Flexibility and Crack Bridging 3.2mm (1/8in.) crack cycling at –26°C (-15°F)	ASTM C836	Pass
Extensibility over 6.4mm (1/4in.) crack after heat aging	ASTM C836	Pass

Footnote:

1. *The membrane is applied to concrete and allowed to cure. Peel adhesion of the membrane is measured at a rate of 50 mm (2 in.) per minute with a peel angle of 90° at room temperature.*

C. Acceptable Materials:

Perm-A-Barrier ® Liquid from Grace Construction Products, 62 Whittemore Avenue, Cambridge, MA.

Or approved equal

2.03 TRANSITION MEMBRANE

A. Description: 36 mil (0.9 mm) of self-adhesive rubberized asphalt integrally bonded to 4 mil (0.1 mm)of cross-laminated, high-density polyethylene film to provide a min. 40 mil (0.1 mm) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Performance Requirements:

1. Water Vapor Transmission: ASTM E 96, Method B: 2.9 ng/m2sPa (0.05 perms) max.
2. Air Permeance at 75Pa (0.3 in. water) pressure difference: 0.0006 L/(s.m^2) (0.00012 cfm/ft^2) max.
3. Puncture Resistance, ASTM E 154: 178 N (40 lbs.) min.
4. Lap Adhesion at –4°C (25°F), ASTM D 1876: 880 N/m (5.0 lbs./in.) of width
5. Low Temperature Flexibility, ASTM D 1970: Unaffected to –43°C (-45°F).
6. Tensile Strength, ASTM D 412, Die C Modified: min. 2.7 MPa (400 psi)
7. Elongation, Ultimate Failure of Rubberized Asphalt, ASTM D 412 Die C: min. 200%

C. Acceptable Materials:
Perm-A-Barrier Detail Membrane manufactured by Grace Construction Products.

2.04 TRANSITION ALUMINUM MEMBRANE

A. Description: 35 mil (0.9 mm) of self-adhesive rubberized asphalt integrally bonded to 5 mil (0.1 mm)of aluminum film to provide a min. 40 mil (1.0 mm) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Performance Requirements:

1. Water Absorption, ASTM D570: max 0.1% by weight
2. Puncture Resistance, ASTM E154: 355N (80 lbs) min.
3. Lap Adhesion at -4ºC (25ºF), ASTM D1876 Modified: 880 N/m (5.0 lbs./in.) of width
4. Low Temperature Flexibility, ASTM D1970 Modified: Unaffected to -26ºC (-15ºF)
5. Tensile Strength, ASTM D412, Die C Modified: min. 4.1 MPa (600 Psi)
6. Elongation, Ultimate Failure of Rubberized Asphalt, ASTM D412, Die C Modified: min. 200%

C. Acceptable Materials:

Perm-A-Barrier Aluminum Flashing manufactured by Grace Construction Products.

2.05 FLEXIBLE MEMBRANE THROUGH-WALL FLASHING

A. Description: 32 mil (0.8 mm)of self-adhesive rubberized asphalt integrally bonded to 8 mil (0.2 mm) of cross-laminated, high-density polyethylene film to provide a min. 40 mil (1.0 mm) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Performance Requirements:

1. Water Vapor Transmission, ASTM E 96, Method B:	2.9 ng/m2sPa (0.05 perms) max.
2. Water Absorption, ASTM D 570:	max. 0.1% by weight
3. Puncture Resistance, ASTM E 154:	356 N (80 lbs.) min.
4. Tear Resistance	
a. Initiation, ASTM D 1004:	min. 58 N (13.0 lbs.) M.D.
b. Propagation, ASTM D 1938:	min. 40 N (9.0 lbs.) M.D.
5. Lap Adhesion at -4ºC (25ºF), ASTM D 1876:	880 N/m (5.0 lbs./in.) of width
6. Low Temperature Flexibility, ASTM D 1970:	Unaffected to -43ºC (-45ºF)
7. Tensile Strength, ASTM D 412, Die C Modified:	min. 5.5 MPa (800 psi)
8. Elongation, Ultimate Failure of Rubberized Asphalt, ASTM D412, Die C:	min. 200%

C. Acceptable Materials:

Perm-A-Barrier Wall Flashing manufactured by Grace Construction Products.

[Spec. Note: Perm-A-Barrier Aluminum Flashing is not to be used when materials that could cause corrosion of aluminum, such as stucco, are to be in direct contact with the aluminum facing of the Perm-A-Barrier Aluminum Flashing]

2.06 AIR & VAPOR BARRIER ACCESSORIES

A. Description: Water-based primer which imparts an aggressive, high tack finish on the treated substrate

1. Flash Point: No flash to boiling point
2. Solvent Type: Water
3. VOC Content: Not to exceed 10 g/l
4. Application Temperature: -4°C (25°F) and above
5. Freezing point (as packaged): -7°C (21°F)

Product: Perm-A-Barrier WB Primer manufactured by Grace Construction Products.

B. Description: Two part, elastomeric, trowel grade material designed for use with self-adhered membranes and tapes. 10 g/l max. VOC Content.

Product: Bituthene® Liquid Membrane manufactured by Grace Construction Products.

C. Optional Primers:

1. Description : Water-based primer which imparts an aggressive, high tack finish on the treated substrate. 1 g/l max. VOC Content.

Product : Perm-A-Barrier Primer Plus manufactured by Grace Construction Products.

2. Description: High tack water based primer. 10 g/l max. VOC content.

Product: Perm-A-Barrier Liquid Part B manufactured by Grace Construction Products.

PART 3 EXECUTION

3.01 EXAMINATION

A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Refer to manufacturer's literature for requirements for preparation of substrates. Surfaces shall be sound and free of voids, spalled areas, lose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods that are acceptable to manufacturer of the fluid-applied waterproofing.

B. Exterior sheathing panels: Ensure that the boards are sufficiently stabilized with corners and edges fastened with appropriate screws. Pre-treat all board joints with 50 - 75mm (2-3 in.) wide, reinforced self-adhesive tape or fiberglass mesh style wallboard tape. Gaps greater than 6mm (1/4 in.) should be filled with mastic or caulk, allowing sufficient time to fully cure before application of the tape and fluid applied membrane.

C. Masonry Substrates: Apply air and vapor barrier over concrete block and brick with smooth flush mortar joints. Fill all voids and holes, particularly in the mortar joints, with a lean mortar mix, non-shrinking grout or parge coat.

D. Related Materials: Treat construction joints and install flashing as recommended by manufacturer.

3.03 INSTALLATION

A. Refer to manufacturer's literature for recommendations on installation

B. Application of Fluid Applied Membrane

1. Spray or trowel apply a continuous uniform film at min. 60 mil (1.5 mm or .060 in.) dry film thickness using multiple, overlapping passes.
2. When spraying use a cross-hatching technique (alternating horizontal and vertical passes) to ensure even thickness and coverage.
3. When spraying use high pressure, multi-component, airless spray equipment approved by material manufacturer.

4. Carry membrane into any openings a minimum of 50mm (2 in.).
5. Seal all brick-ties and other penetrations as work progresses.

C. Application of Transition Membrane
1. After allowing the Fluid Applied Membrane to cure to tack-free, apply transition membrane with a minimum overlap of 75mm (3 in.) onto each surface at all beams, columns and joints as indicated in detail drawings.
2. Tie in to window and door frames, spandrel panels, roof and floor intersections and changes in substrate.
3. Use pre-cut, easily handled lengths for each location.
4. Remove silicone-coated release paper and position membrane flashing carefully before placing it against the surface.
5. When properly positioned, place against surface by pressing firmly into place by hand roller.
6. Overlap adjacent pieces 50 mm (2 in.) and roll all seams with a hand roller.
7. Seal top edge of flashing with termination mastic.
8. When transition flashing is pre-installed prior to application of Fluid Applied Membrane, apply transition flashing as above. Spray or trowel a continuous uniform film of Fluid Membrane at min. 60 mil (1.5 mm or .060 in.) dry film thickness using multiple, overlapping passes, with a minimum overlap of 75 mm (3 in.) onto transition flashing. For sill condition, spray or trowel Fluid Membrane onto pre-installed sill flashing and onto horizontal section of sill.

D. Application of Flexible Membrane Wall Flashing
1. Precut pieces of flashing to easily handled lengths for each location.
2. Remove silicone-coated release paper and position flashing carefully before placing it against the surface.
3. When properly positioned, place against surface by pressing firmly into place by hand roller. Fully adhere flashing to substrate to prevent water from migrating under flashing.
4. Overlap adjacent pieces 50 mm (2 in.) and roll all seams with a hand roller.
5. Trim bottom edge 13 mm (1/2 in.) back from exposed face of the wall. Flashing shall not be permanently exposed to sunlight.
6. At heads, sills and all flashing terminations, turn up ends a minimum of 50 mm (2 in.) and make careful folds to form an end dam, with the seams sealed.
7. Seal top edge of flashing with termination mastic.
8. Do not allow the rubberized asphalt surface of the flashing membrane to come in contact with poly-sulfide sealants, creosote, uncured coal tar products or EPDM.

3.06 PROTECTION AND CLEANING

A. Remove any masking materials after installation. Clean any stains on materials that would be exposed in the completed work using procedures as recommended by manufacturer.
B. Perm-A-Barrier Liquid is not suitable for permanent exposure and should be protected from the effects of sunlight.

C. Schedule work to ensure that the Perm-A-Barrier Liquid system is covered as soon as possible after installation. Protect Perm-A-Barrier Liquid system from damage during subsequent operations. If the Perm-A-Barrier Liquid system cannot be covered within 60 days after installation, apply temporary UV protection such as dark plastic sheet or tarpaulins.

END OF SECTION

SECTION 073216 - CONCRETE ROOF TILES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete roof tiles.
2. Underlayment materials.
3. Ridge vents.
4. Metal flashing and trim.

1.3 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified under this Section.

1.4 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified under this Section.

1.5 DEFINITIONS

A. Roofing Terminology: See ASTM D1079 and glossary in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" for definitions of terms related to roofing Work in this Section.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Job Site.

1. Required Participants:
    a. General Contractor
    b. Owner Representative
    c. Architect

1.7 ACTION SUBMITTALS

A. Product Data: For the following:

1. Concrete roof tiles.
2. Underlayment materials.
3. Ridge vents.
4. Asphalt roofing cement.
5. Butyl sealant.
6. Elastomeric sealant.
7. Mortar.
8. Eave closure.
9. Ridge closure.

B. Shop Drawings: For metal flashing and trim.

C. Samples: For each exposed product and for each color and texture specified, in sizes indicated.

1. Concrete Roof Tiles: Full size, showing full range of color values and blends.
2. Accessory Tiles: Full size, each type.
3. Metal Flashing: 12 inches square.
4. Ridge Vents: 12-inch-long Sample.
5. Eave Closures: In manufacturer's standard size.

D. Samples for Initial Selection: For each type of concrete roof tile and accessory tile.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For the following products, in sizes indicated:

1. Concrete Roof Tiles: Full size, showing full range of color values and blends.
2. Accessory Tiles: Full size, each type.
3. Metal Flashing: 12 inches square.
4. Ridge Vents: 12-inch-long Sample.
5. Eave Closures: In manufacturer's standard size.

1.8 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each type of concrete roof tile, based on evaluation of comprehensive tests performed by a qualified testing agency.

B. Research Reports: From an agency acceptable to authorities having jurisdiction, indicating that product is suitable for intended use under applicable building codes for the following:

1. Wire-tie tile-attachment systems.
2. Polymer-modified bitumen sheet underlayment.
3. Type M Mortar

C. Sample Warranty: For manufacturer's materials warranty.

1.9 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing to include in maintenance manuals.

B. Materials warranties.

C. Roofing Installer's warranty.

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Concrete Roof Tiles: 100SF of each type, in unbroken bundles.

1.11 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for concrete roof tiles including related roofing materials.

a. Size: 48 inches by 48 inches.
b. Include gutter and downspout complying with requirements in
1) Section 076200 Sheet Metal Flashing and Trim.
2) Section 077200 Roof Accessories

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Store underlayment rolls in a dry, well-ventilated location protected from weather, sunlight, and moisture in accordance with manufacturer's written instructions.

1. Store on end, on pallets or other raised surfaces. Do not double-stack rolls.

B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

C. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.13 FIELD CONDITIONS

A. Environmental Limitations: Proceed with installation only when existing and forecasted weather conditions permit product installation and related work to be performed in accordance with manufacturer's written instructions and warranty requirements.

1. Install self-adhering, polymer-modified bitumen sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.14 WARRANTY

A. Materials Warranty: Manufacturer agrees to repair or replace concrete roof tiles that fail in materials within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Roofing Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of concrete-tile roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. To match existing building roof tile.

B. Obtain each type of product from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: Provide concrete roof tiles and related roofing materials identical to those of assemblies tested for Class A fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

B. Energy Performance, ENERGY STAR: Provide roof tiles that are listed on the DOE's "ENERGY STAR Roof Product List" for steep-slope roof products.

2.3 CONCRETE ROOF TILES

A. Concrete Roof Tiles: ASTM C1492, molded- or extruded-concrete roof tile units of shape and configuration indicated, with integral color, and free of surface imperfections. Provide with fastening holes prepunched at factory.
1. Weight: Conventional

2. High-Profile Shape: Type I, Capistrano (Spanish “S” interlocking)

   a. Accessory Tiles: Type IV, ridge, ridge vent, ridge end, hip and hip starter, header course, L-shaped rake edge, roll rake edge, starter, end band, and terminal

3. Size: Match existing

4. Colors, Blends, and Patterns: To match existing buildings roof tile.

2.4 UNDERLAYMENT MATERIALS

A. Felt:
   1. ASTM D226/D226M Type II, asphalt saturated
   2. ASTM D4869/D4869M Type IV, asphalt saturated
   3. ASTM D2626/D2626M, asphalt saturated and coated, mineral-granule surfaced on weather (top) side

B. Asphalt Roll-Roofing: ASTM D6380/D6380M, Class M, Type II, asphalt-saturated and -coated organic felt; mineral-granule surfaced on weather (top) side.

C. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; recommended, in writing, by manufacturer for use under roof tile; and evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.

2.5 RIDGE VENTS

A. Rigid-Plastic Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent for use under ridge tiles.
   1. Install per manufacturers requirements

B. Flexible Ridge Vent: Manufacturer's standard roll-form ridge vent that protects against driven rain and snow and is recommended in writing by manufacturer for installation with roof tile indicated.
   1. Install per manufacturers requirements

2.6 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D4586/D4586M Type II, asbestos free.

B. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.

C. Elastomeric Sealant: ASTM C920, Type S, Grade NS, one-part, non-sag, elastomeric polymer sealant of class and use classifications required to seal joints in concrete-tile roofing and remain watertight; recommended in writing by manufacturer for applications indicated.

D. Roofing Asphalt: ASTM D312/D312M Type IV.

E. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with underlayments.

F. Mortar: ASTM C270, Type M, color to match existing with ASTM C979/C979M, pigmented mortar. If retaining "Foam Adhesive" Paragraph below, verify years of in-service experience with adhesive recommended by roof-tile manufacturers.

G. Foam Adhesive: Two-component, polyurethane expanding adhesive recommended in writing for application by concrete-roof-tile manufacturer.

H. Eave Closure: Manufacturer's standard eave closure to match existing formed to shape of concrete roof tiles.

I. Ridge Closure: Manufacturer's standard ridge closure, formed to shape of concrete roof tiles.

J. Wood Nailers: Comply with requirements for pressure-preservative-treated wood in Section 061000 "Rough Carpentry.

K. Mesh Fabric: PVC-coated, glass-fiber thread.

2.7 FASTENERS

A. Roofing Nails: ASTM F1667, hot-dip galvanized-steel, 0.120-inch diameter shank, sharp-pointed, conventional roofing nails with barbed shanks; minimum 3/8-inch diameter head; of sufficient length to penetrate 3/4 inch into substrate or extend at least 1/8 inch through thickness of the sheathing, whichever is less.

1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

B. Underlayment Nails: Hot-dip galvanized-steel wire nails with low-profile metal caps, 1-inch minimum diameter.

1. Provide with minimum 0.0134-inch thick metal cap or 0.010-inch thick power-driven metal cap; and with minimum 0.083-inch thick ring shank or 0.091-inch thick smooth shank of length to penetrate at least 3/4 inch into roof sheathing or to penetrate through roof sheathing less than 3/4 inch thick.

C. Nails for Wood Nailers: ASTM F1667; common or box, steel wire, flat head, and smooth shank.

D. Wire Ties: Stainless steel, 0.083-inch minimum diameter.

E. Twisted-Wire-Tie System: Continuously

F. Hook Nails: One-piece wind lock and concrete-roof-tile fastener system, minimum 0.120-inch-diameter galvanized-steel wire, for direct deck nailing.

G. Tile Locks: Hot-dip galvanized-steel, nominal 0.1-inch diameter wire device designed to secure butt edges of overlaid concrete roof tiles.

H. Storm Clips: Hot-dip galvanized-steel, minimum 0.048-by-1/2-inch strap-type, L-shaped retainer clips designed to secure side edges of concrete roof tiles. Provide with two fastener holes in base flange.

2.8 METAL FLASHING AND TRIM

A. General: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Sheet Metal: Match existing.

B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for design, dimensions, metal, and other characteristics of the item unless otherwise specified in this Section or indicated on Drawings.

1. Apron Flashings: Fabricate with lower flange extending a minimum of 6 inches over and 4 inches beyond each side of downslope tile roofing and 6 inches up the vertical surface.
2. Step Flashings: Fabricate with a headlap of 4 inches and a minimum extension of 5 inches both horizontally and vertically.
3. Channel Flashings: Fabricate with vertical surface extending a minimum of 5 inches above the concrete roof tile and 6 inches beneath the tile roofing, with a 1-inch high vertical return to form a runoff channel.
4. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and 6 inches beneath the tile roofing, with a 1-inch high vertical return to form a runoff channel.
5. Cricket and Backer Flashings: Fabricate with concealed flange extending a minimum of 24 inches beneath upslope tile roofing and 6 inches above the roof plane.
6. Counterflashings: Fabricate to cover 4 inches of base flashing measured vertically; and in lengths required so that no step exceeds 8 inches and overall length is no more than 10 feet.

    a. Provide metal receivers for installation.

7. Valley Flashings: Fabricate from metal sheet not less than 24 inches wide in lengths not exceeding 10 feet with 1-inch high, inverted-V profile water diverter at center of valley and equal flange widths of not less than 11 inches.

    a. Hem flange edges for fastening with metal cleats.

8. Drip Edges: Fabricate in lengths not exceeding 10 feet, with minimum 2-inch roof-deck flange and 1-1/2-inch fascia flange with 3/8-inch drip at lower edge.

C. Sheet Metal Ridge Vent: Fabricate from 16-oz./SF thick copper sheet, terminating each side in V-shaped external baffles with venting holes producing net free ventilation area of 2.65 sq. in./ft.

D. Vent-Pipe Flashings: ASTM B749, Type L51121, at least 1/16 inch thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches from pipe onto roof.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provisions have been made for flashings and penetrations through roofing.
3. Verify that vent stacks and other penetrations through roofing are installed and securely fastened.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT MATERIALS

A. Comply with concrete-roof-tile and underlayment manufacturers' written installation instructions and with recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" applicable to products and applications indicated unless more stringent requirements are specified in this Section or indicated on Drawings.

1. Cover ridge wood nailers with underlayment strips.

B. Felt: Install parallel with and starting at eaves and fasten with underlayment nails.

1. Single-Layer Installation: Install on roof deck.

a. Lap sides a minimum of 4 inches over underlying course.
b. Lap ends a minimum of 4 inches.
c. Stagger end laps between succeeding courses at least 72 inches.

2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

a. Lap sides a minimum of 4 inches over underlying course.
b. Lap ends a minimum of 4 inches.
c. Stagger end laps between succeeding courses at least 72 inches.

3. Double-Layer Installation: Install on roof deck.

a. Install a 19-inch wide starter course at eaves and completely cover with a 36-inch wide second course.
b. Install succeeding 36-inch wide courses lapping previous courses 19 inches in shingle fashion.

c. Lap ends a minimum of 6 inches.
d. Stagger end laps between succeeding courses at least 72 inches.
e. Apply a continuous layer of asphalt roofing cement over starter course and on felt surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof.

4. Install fasteners in a grid pattern of 12 inches between side laps with 6-inch spacing at side and end laps.
5. Install felt over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate felt extended up not less than 4 inches against sidewalls, curbs, chimneys, and other roof projections.

C. Asphalt Roll-Roofing: Install parallel with and starting at eaves.

1. Single-Layer Installation: Install on roof deck.

a. Lap sides a minimum of 4 inches over underlying course.
b. Lap ends a minimum of 4 inches.
c. Stagger end laps between succeeding courses at least 72 inches.
d. Fasten with underlayment nails.

2. Top-Layer Installation: Install as second layer over anchor-layer underlayment, with side laps offset halfway between side laps of underlying anchor layer.

a. Lap sides a minimum of 4 inches over underlying course.
b. Lap ends a minimum of 4 inches .
c. Stagger end laps between succeeding courses at least 72 inches.
d. Fasten with underlayment nails

3. Double-Layer Installation: Install on roof deck.

a. Install a 19-inch wide starter course at eaves and completely cover with a 36-inch wide second course.
b. Install succeeding 36-inch wide courses lapping previous courses 19 inches in shingle fashion.
c. Lap ends a minimum of 6 inches.
d. Stagger end laps between succeeding courses at least 72 inches.
e. Fasten with underlayment nails.
f. Apply a continuous layer of asphalt roofing cement over starter course and on roll-surface to be concealed by succeeding courses as each roll-roofing course is installed. Apply over entire roof.

4. Install fasteners in a grid pattern of 12 inches between side laps with 6-inch spacing at side and end laps.
5. Install roll roofing over areas protected by self-adhering, polymer-modified bitumen sheet.
6. Terminate roll roofing extended up not less than 4 inches against sidewalls, curbs, chimneys, and other roof projections.

D. Synthetic-Underlayment Top Layer: Install in accordance with manufacturer's written installation instructions and as second layer over anchor-layer underlayment.

1. Completely cover anchor-layer underlayment and install parallel with and starting at the eaves, with side laps offset halfway between side laps of underlying anchor layer.
2. Lap sides and ends as recommended in writing by manufacturer, but not less than 4 inches for side laps and 6 inches for end laps.
3. Stagger end laps from anchor-layer end laps and between succeeding top courses at interval recommended in writing by manufacturer, but not less than 72 inches.
4. Fasten with underlayment nails.
5. Install fasteners in a grid pattern of 12 inches between side laps with 6-inch spacing at side and end laps.

E. Valley Underlayment: Install one layer of 36-inch- wide underlayment centered in valley, running full length of valley, and on top of underlayment on field of roof that is woven through valley. Install all layers of underlayment in and through valley tight with no bridging.

1. Use same underlayment as installed on field of roof
2. Lap ends at least 12 inches in direction that sheds water, and seal with asphalt roofing cement.
3. Fasten to roof deck with underlayment nails located as far from valley center as possible and only to extent necessary to hold underlayment in place until installation of valley flashing.
4. Solidly cement valley underlayment to roof-field underlayment that is woven through valley using asphalt roofing cement.

3.3 INSTALLATION OF METAL FLASHING AND TRIM

A. Install metal flashings and other sheet metal to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

1. Install metal flashings in accordance with concrete-roof-tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems."

B. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.

C. Step Flashings: Install with a headlap of 4 inches and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.

D. Cricket and Backer Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.

E. Channel Flashings: Install over underlayment materials and fasten to roof deck.

F. Rake Pan Flashings: Install over underlayment materials and fasten to roof deck.

G. Counterflashings: Coordinate with installation of base flashing and fit tightly to base flashing. Lap joints a minimum of 4 inches secured in a waterproof manner.

1. Install in reglets or receivers.

H. Valley Flashings: Install centered in valleys, lapping ends at least 8 inches in direction that sheds water. Fasten upper end of each length to roof deck beneath overlap.

1. Secure hemmed flange edges into metal cleats spaced 12 inches apart and fastened to roof deck.
2. Adhere minimum 9-inch wide strips of self-adhering, polymer-modified bitumen sheet to metal flanges and to polymer-modified bitumen sheet. Place strips parallel to and over flanges so that they will be just concealed by installed tile.
3. Provide a closure at the end of the inverted-V profile of the valley metal to minimize water and ice infiltration.

I. Rake Drip Edges: Install over underlayment materials and fasten to roof deck.

J. Eave Drip Edges: Install below underlayment materials and fasten to roof deck.

K. Sheet Metal Ridge Vents: Install centered on and mechanically fasten to wood ridge. Adhere each side to concrete roof tile with elastomeric sealant.

1. Install fabric mesh over roof-deck air ventilation gaps to prevent insect entry.

L. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.

3.4 INSTALLATION OF WOOD NAILERS

A. Install wood nailers securely fastened to roof deck at the following locations:

1. Hips.
2. Ridges.
3. Rakes.

B. Install beveled wood-cant nailers at eaves and securely fasten to roof deck.

C. Install nominal 1-by-2-inch wood-batten nailers horizontally over 1/2-inch- (13-mm-) high, pressure-preservative-treated wood lath strips at spacing required by concrete-roof-tile manufacturer, and securely fasten to roof deck.

1. Install nominal 1-by-2-inch wood counter battens vertically spaced 24 inches apart and securely fasten to roof deck.

3.5 INSTALLATION OF CONCRETE ROOF TILES

A. Install concrete roof tiles in accordance with manufacturer's written instructions and recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Installation Manual" and NRCA's "The NRCA Roofing Manual: Steep-Slope Roof Systems" unless more stringent requirements are specified in this Section or indicated on Drawings.

1. Install tiles to resist wind forces resulting from design wind speeds indicated on Drawings.
2. Maintain uniform exposure and coursing of concrete roof tiles throughout roof.

3. Extend tiles 2 inches over eave fasciae.
4. Nail Fastening: Drive nails to clear the concrete roof tile so the tile hangs from the nail and is not drawn up.

    a. Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.

5. Wire-Tie Fastening: Install wire-tie systems and fasten concrete roof tiles in accordance with manufacturer's written instructions.
6. Mortar Setting: Install concrete roof tiles in accordance with manufacturer's written instructions and acceptance criteria of authorities having jurisdiction.
7. Foam-Adhesive Setting: Install concrete roof tiles in accordance with adhesive and tile manufacturers' written instructions and acceptance criteria of authorities having jurisdiction.
8. Storm Clips: Install to capture edges of longitudinal sides of concrete roof tiles and securely fasten to roof deck.
9. Tile Locks: Install to support and lock overlying tile butts to underlying tiles.
10. Cut and fit concrete roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
11. Install concrete roof tiles with color blend approved by Architect.

B. Low-Profile, Flat-Shingle Concrete-Roof-Tile Installation:

1. Maintain 2-inch headlap between succeeding courses of concrete roof tiles.
2. Offset joints by half the concrete-roof-tile width in succeeding courses.
3. Extend concrete roof tiles 1 inch over fasciae at rakes.
4. Install ridge tiles in saddle configuration with laps facing away from prevailing wind. Seal laps with asphalt roofing cement or elastomeric sealant.

    a. Close voids where ridge tiles meet concrete roof tiles with mortar struck with face of ridge cover tiles.

5. Install hip tiles in saddle configuration. Seal laps with asphalt roofing cement or elastomeric sealant.

    a. Fill voids with mortar where hip tiles meet concrete roof tiles, and strike mortar flush with face of hip cover tiles.

C. Medium-Profile, Interlocking Concrete-Roof-Tile Installation:

1. Provide minimum 3-inch lap between succeeding courses of concrete roof tiles.
2. Install rake tiles indicated.
3. Install ridge tiles with laps facing away from prevailing wind. Seal laps with asphalt roofing cement or elastomeric sealant.

D. Open Valleys: Cut concrete roof tiles at open valleys to form straight lines. Maintain uniform width of exposed open valley 1/8 inch in 12 inches from highest to lowest point.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

E. Closed Valleys: Cut concrete roof tiles at closed valleys to form straight lines, trimming upper concealed corners of tiles. Maintain uniform gap of 3/4 to 1 inch on either side of water diverter at valley centerline.

1. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
2. Do not nail tiles to metal flashings.

F. Remove and replace damaged or broken concrete roof tiles.

3.6 INSTALLATION OF RIDGE VENTS

A. Rigid-Plastic Ridge Vents: Install continuous ridge vents over concrete roof tiles in accordance with manufacturer's written instructions. Fasten with nails of sufficient length to penetrate substrate.

B. Flexible Ridge Vent: Install continuous-roll ridge vents over concrete roof tiles in accordance with manufacturer's written instructions.

3.7 ROOFING INSTALLER'S WARRANTY

A. Materials Warranty: Manufacturer agrees to repair or replace concrete roof tiles that fail in materials within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Roofing Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of concrete-tile roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

C. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant the work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

D. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that, during Warranty Period, Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of the work as are necessary to correct faulty and defective work and as are necessary to maintain the work in a watertight condition.

E. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to the work and other parts of the building, and to building contents, caused by:

a. Lightning;
b. Fire;

c. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
d. Faulty construction of copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
e. Vapor condensation on bottom of roofing; and
f. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When the work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to the work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the work.
4. During Warranty Period, if Owner allows alteration of the work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of the alterations, but only to the extent the alterations affect the work covered by this Warranty. If Owner engages Roofing Installer to perform the alterations, Warranty shall not become null and void unless Roofing Installer, before starting the alterations, notified Owner in writing, showing reasonable cause for claim, that the alterations would likely damage or deteriorate the work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty shall become null and void on date of the change, but only to the extent the change affects the work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect the work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on the work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of the work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

END OF SECTION 073216

SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Adhered TPO membrane roofing system.
2. Vapor retarder.
3. Roof insulation.
4. EPDM Parapet back treatment

B. Section includes the installation of acoustical roof deck rib insulation strips furnished under Section 053100 "Steel Decking."

C. Related Sections:

1. Section 061000 "Rough Carpentry for wood nailers, curbs, and blocking.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
4. Section 077129 "Manufactured Roof Expansion Joints" for proprietary manufactured roof expansion-joint assemblies.
5. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
6. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 DEFINITIONS

A. TPO: Thermoplastic polyolefin.

B. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.

1. Corner Uplift Pressure *77.3* lbf/sq. ft.
2. Perimeter Uplift Pressure: *51.2* lbf/sq. ft..
3. Field-of-Roof Uplift Pressure: *30.7* lbf/sq. ft..

D. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

E. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened membrane roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

C. Samples for Verification: For the following products:

1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
2. Roof insulation.
3. Walkway pads or rolls.
4. Metal termination bars.
5. Battens.
6. Six insulation fasteners of each type, length, and finish.
7. Six roof cover fasteners of each type, length, and finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer.

B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of compliance with performance requirements.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

D. Field quality-control reports.

E. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. Source Limitations: Obtain components including roof insulation, fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.

D. Exterior Fire-Test Exposure: ASTM E 108, Class C; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

E. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

F. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.

7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

G. Pre-installation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.10 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Manufacturer's warranty: Provide roofing manufacturer's total system leak-tight 20-year labor and 20-year material "No Dollar Limit Warranty" including insulation and all components. The warranty shall contain no exclusion or limitation for improper installation, damage from water that ponds, or does not drain freely. Provide all details necessary to qualify for manufacturer's "No Dollar Limit Warranty" and the manufacturer will respond within 48 hours and repair within 5 business days any leaks in the roofing assembly for the warranty period stated at no cost to the Owner, unless the leak is determined to be caused by others.

B. Roofers Guarantee: provide written guarantee from the Contractor stating that the Contractor will respond with 24 hours and repair within 5 business days any leaks or defects in the roofing assembly for 2 years at no cost to the Owner.

PART 2 - PRODUCTS

2.1 TPO MEMBRANE ROOFING

A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed TPO sheet.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

   a. Carlisle SynTec Incorporated.
   b. Firestone Building Products Company.
   c. Johns Manville.

2. Thickness: 60 mils (1.5 mm), nominal.
3. Exposed Face Color: White.

B. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Single-Ply Roof Membrane Adhesives: 250 g/L.
    f. Other Adhesives: 250 g/L.
    g. Single-Ply Roof Membrane Sealants: 450 g/L.
    h. Nonmembrane Roof Sealants: 300 g/L.
    i. Sealant Primers for Nonporous Substrates: 250 g/L.
    j. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as sheet membrane.

C. Bonding Adhesive: Manufacturers standard; VOC shall be less than 250 grams per liter less water.

D. Slip Sheet: Manufacturer's standard, of thickness required for application.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), pre-punched.

G. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.3 SUBSTRATE BOARDS

A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch (13 mm) thick.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Georgia-Pacific Corporation; Dens Deck Prime.
    b. Or prior approved equal.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.4 VAPOR RETARDER

A. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

1. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
2. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.

B. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m)[and with manufacturer's standard adhesive].

C. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

2.5 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by TPO membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation.

B. Poly Isocyanurate Board Insulation: ASTM E84, NFPA 285 and 286 closed cell poly isocyanurate foam core laminated to a reinforced mat facer on both major surfaces.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

2.7 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

D. Install acoustical roof deck rib insulation strips, specified in Section 053100 "Steel Decking," according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

3.3 SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

2. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

3.4 VAPOR-RETARDER INSTALLATION

A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.

1. Continuously seal side and end laps with tape or adhesive.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

3.5 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck.

1. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
2. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

I. Install slip sheet over cover board and immediately beneath membrane roofing.

3.6 ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.

B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.

E. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.

F. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

H. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

I. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

3.7 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.8 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.11 ROOFING INSTALLER'S WARRANTY

A. WHEREAS <**Insert name**> of <**Insert address**>, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: NMSU.
2. Address: .
3. Building Name/Type: .
4. Address: .
5. Area of Work: Roof.
6. Acceptance Date: <**Insert date**>.
7. Warranty Period: <**Insert time**>.
8. Expiration Date: <**Insert date**>.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. Lightning;
    b. Peak gust wind speed exceeding 90 mph;
    c. Fire;
    d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. Vapor condensation on bottom of roofing; and
    g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing

Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <**Insert day**> day of <**Insert month**>, <**Insert year**>.

1. Authorized Signature: <**Insert signature**>.
2. Name: <**Insert name**>.
3. Title: <**Insert title**>.

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flashings, counter flashings, scuppers, sheet metal roofing, edge strips, and fabricated sheet metal items.

B. Pre-cast concrete splash pads.

1.02 RELATED SECTIONS

A. Section 074213 – Metal Wall Panels.

B. Section 074243 – Composite Wall Panels

C. Section 077200 – Roof Accessories: Roof Hatches: Metal curbs.

D. Section 079200 – Joint Sealers.

E. Section 099100 - Painting: Field painting.

1.03 REFERENCES

A. ASTM A 653/A 653M - Standard Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 1997.

B. ASTM B 32 - Standard Specification for Solder Metal; 1996.

C. ASTM D 2178 - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing; 1997a.

D. ASTM D 4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 1993.

E. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 1993, Fifth Edition.

F. NRCA – The NRCA Architectural Sheet Metal and Metal Roofing Manual, 2006 Edition

1.04 SUBMITTALS

A. See Section 013300 – Submittal Procedures.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods,

flashings, terminations, and installation details. Submit color chart for pre-finished materials.

C. Submit roof manufacturer's certification that metal fasteners and sealants are acceptable to roof manufacturer.

D. Cut sheets on all products

E. Submit copies of all warranties

F. Refer to specification Section 01 8113 Part 1.5 for LEED product submittal requirements

1.05 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual and The NRCA Architectural Sheet Metal and Metal Roofing Manual requirements and standard details, except as otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

C. Prevent contact with materials which may cause discoloration or staining.

1.07 WARRANTIES:

A. 20 year coating warranties on all coated metals

B. 20year NDL warranties on all coping

C. All copings and edge metals must meet ES-1 Code requirements

PART 2 PRODUCTS

2.01 SHEET MATERIALS

A. Galvanized Steel: ASTM A 653/A 653M, with G90/Z275 zinc coating; 20 gage thick steel; pre-finished fluorocarbon coating system unless noted otherwise on the drawings.

B. Membrane coated metal is to be used as shown in plans and roof membrane specification section.

C. Provide submittals as required by section 01 8113 Supplemental Table:

a. Submittal Requirements for LEED v4 Environmental Quality Credits.
b. Submittal Requirements for LEED v4 Environmental Quality Credits

2.02 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.

B. Underlayment: ASTM D 2178, glass fiber roofing felt.

C. Primer: Zinc chromate type.

D. Protective Backing Paint: Zinc chromate alkyd.

E. Sealant: Type B specified in Section 07900.

F. Plastic Cement: ASTM D 4586, Type I.

G. Solder: ASTM B 32; Sn50 (50/50) type.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch; miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

E. Fabricate corners from one piece with maxium18 inch long legs; the corners are to be mitered and folded together with the folded metal sealed water tight with sealant between the folds. Seam for rigidity, seal with sealant.

F. Fabricate vertical faces with bottom edge formed outward ¼" or ½"inch (6 mm) and hemmed to form drip.

G. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

H. All metal roof counterflashings are to be 2-piece (reglet with flashing insert). All metal flashing and reglet corners are to be mitered, caulked and pop riveted in a watertight manner. The reglet mitered corners are to be fabricated with legs no longer than 18."

2.05 COPING FABRICATION

A. Coping will be prefabricated from iron sheet metal with gauge, finish and profile as indicated on the Drawings.

B. Cover and splice plates will be installed.

C. Coping will be tapered to drain water to the inside.

D. Coping corners are to be mitered, sealed and pop riveted with 30” outside legs. Pop rivets are to penetrate through sealant.

E. Coping Tee joints are to be fabricated with a 5’ top of the Tee and a 30” leg inserted under the top of the Tee, sealed and pop-riveted. Pop rivets are to penetrate through sealant.

PART 3 EXECUTIONS

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 6 MILS.

3.03 INSTALLATION

A. Insert flashings into reglets to form tight fit. Secure in place with lead wedges and pack remaining spaces with lead wool for masonry saw cut reglet. Seal flashings reglet with one part urethane caulking on surface mounted counterflashings.

B. For surface mounted type reglet: set reglet into 1” butyl tape and fasten reglet to wall 12” O.C through butyl tape. Seal top of reglet with one part urethane caulking. For stucco stop type reglet: fasten reglet to wall 12” O.C

C. All metal flashing and reglet lap joints are to be lapped 3”. Reglet lap joints are to be caulked with urethane caulking between the two pieces. The two pieces are to fit flush with one another. Wind clips 1” wide are to be installed spaced 3’ O.C.

D. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

E. Apply plastic cement compound between asphalt primed metal flashings, felt flashings and per NRCA standards.

F. Fit flashings tight in place. Make mitered corners square, surfaces true and straight in planes, and lines accurate to profiles.

G. Solder metal joints for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.

I. Where coping abuts a high wall, a splice plate with edge flanged up and out will be installed against wall. Coping will be set in the four rows of sealant on the splice plate as described above leaving a ¼" separation between coping and wall. A wall flashing will then be installed and sealed around the edges.

J. Coping butt joints are to have both a 6" wide splice plate and 6" wide cover plate at each joint. Separation between coping joints shall be ¼". On each side of the splice plate there is to be two full rows of caulking – one butyl tape to the outside and one polyurethane caulking strip to the inside. Under each side of the cover plate there is to be one row of butyl tape. If the parapet is sloped, 2 pop rivets on the uphill side of the cover plate will be installed through the cover plate, butyl tape, coping and splice plate.

K. Provide submittals as required by section 01 8113 Supplemental Table:

a. Submittal Requirements for LEED v4 Environmental Quality Credits.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Equipment supports.
3. Preformed flashing sleeves.
4. Fall protection
5.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.
3. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint covers.
4. Section 086200 "Unit Skylights" for single- and double-glazed domed plastic skylights with curb frame.
5. Section 230548 "Vibration and Seismic Controls for HVAC" for special curbs designed to accommodate seismic and vibration controls.
6. Section 233423 "HVAC Power Ventilators" for power roof-mounted ventilators.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

D. Delegated-Design Submittal: For roof curbs and equipment supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.

c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof curbs and equipment supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Material: Aluminum sheet, 0.125 inch (3.17 mm) thick.

1. Finish: Clear anodic.

E. Construction:

1. Curb Profile: Profile as indicated on Drawings compatible with roofing system.
2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
3. Fabricate curbs to height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.

5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) or as indicated on theDrawings thick glass-fiber board insulation.
7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
12. Damper Tray: Provide damper tray or shelf with opening 3 inches (76 mm.

2.3 EQUIPMENT SUPPORTS

A. Equipment Supports: Internally reinforced perimeter metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed structure-mounting flange at bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Material: Aluminum sheet, 0.125 inch (3.17 mm) thick.

1. Finish: Clear anodic.

E. Construction:

1. Curb Profile: Manufacturer's standard or as indicated on the Drawings compatible with roofing system.
2. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
4. Nailer: Factory-installed continuous wood nailers 3-1/2 inches (90 mm) wide on top flange of equipment supports, continuous around support perimeter.
5. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.

6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
8. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
9. Fabricate equipment supports to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
10. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow. Retain "Security Grille"

2.4 FALL PROTECTION

A. Horizontal Guardrail
1. Basis of Design; Guardian Fall Protection, Inc.; Free standing guardrail system capable of withstanding loads and stresses within limits and under conditions specified in OSHA and other applicable safety codes. Withstand, without failure, a minimum point load of 200 pounds and applied in any direction at any point on the top edge, 150 pounds applied in any direction at the midrail
2. Rails 42” high with midrail at 21”; finish powder coated safety yellow

B. Tie-Back Davit
1. Basis of Design; Guardian Fall Protection, Inc.; Tie-back anchors shall be designed to meet the requirements of OSHA, ANSI, IWCA and other applicable regulatory codes regarding fall protection and suspended maintenance operations. Anchors for fall protection to be designed to sustain a 5000lb ultimate load
2. Davit Bases steel plates, galvanized steel, or as determined by manufacturer. Size as necessary for proper installation. Contractor to coordinate manufacturer size requirements and recommendations with structural requirements for receiving the Davit Bases and for providing reinforcement.

C. HORIZONTAL FALL PROTECTION
1. Basis of Design; Guardian Fall Protection, Inc.; Provide structural fall restraint and fall arrest system capable of withstanding loads and stresses within limits and under conditions specified in OSHA and other applicable safety codes. Provide fall protection anchors permanently attached to roof structure. Provide cable lifeline system to allow continuous travel past intermediate anchors.
    a. Roof anchors spaced as indicated by manufacturer for safety snap connection by individual workers capable of withstanding a safety factor of 2 meeting the requirements of OSHA 1926.502(d)(8).
    b. Continuous stainless steel cable lifeline restrained by swaged terminations at anchor points, suitable for multiple safety snap connections along cable between anchors.
    c. Tensioning system
    d. Pass-thru technology allowing cable shuttle to run freely past intermediate anchors withat the need to disconnect from the fall protection system.
    e. Fall restraint 4 users
    f. Fall arrest 2 users

g. Design system to limit loads on horizontal lifeline anchors to 1800lbs.

2.

2.5 PREFORMED FLASHING SLEEVES

A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches (300 mm) high, with removable metal hood and perforated metal collar.
   1. Metal: Aluminum sheet, 0.063 inch (1.60 mm) thick.
   2. Diameter: As indicated on Drawings.
   3. Finish: Manufacturer's standard.

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
   1. Metal: Aluminum sheet, 0.063 inch (1.60 mm) thick.
   2. Height: 13 inches (330 mm).
   3. Diameter: As indicated on Drawings.
   4. Finish: Manufacturer's standard.

2.6 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.

C. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C), thickness as indicated.

D. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

G. Underlayment:

   1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
   2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D4397.
   3. Slip Sheet: Building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, rosin sized.
   4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

5. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
6. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
7. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
8. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

H. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

I. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

J. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

K. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.

E. Roof-Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.

F. Preformed Flashing-Sleeve and Flashing Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."
2) Intertek Group in its "Directory of Listed Building Products."
3) FM Global in its "Building Materials Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

F. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Listed Building Products" under "Firestop Systems."

C. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."

END OF SECTION 078413

SECTION 07 91 00

EXPANSION JOINTS- WALLS, FLOORS, CEILINGS AND ROOF

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Preformed, precompressed, expanding foam joint seals for expansion joints in exterior walls.
2. Preformed expansion joint for ceilings.
3. Preformed, Pre-compressed, expanding foam joint seal for expansion joints in slab floors.
4. Preformed, waterproof expansion joint for expansion joints in roof parapets.

B. Related Sections:
1. Division 01: Administrative, procedural, and temporary work requirements.
2. Division 07: Thermal and Moisture Protection.
3. Division 07: Sealants, Caulking, and waterproofing.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Conference:
1. Convene at Project site 2 weeks prior to beginning work of this Section.
2. Attendance: [Architect,] [Contractor,] [Construction Manager,] joint seal installer, and related trades
3. Review and discuss:
   a. Joint seal manufacturer's requirements, project conditions, allowable structural movement at joints, and protection of completed work.
   b. Transitions in plane and direction, and requirement for continuity of seal through watertight transitions from wall expansion joint to other interfacing expansion joint systems at adjacent construction.

1.3 SUBMITTALS

A. Action Submittals:
1. Shop Drawings:
   a. Indicate joint locations, dimensions, and adjacent construction.
   b. Provide details for transitions in plane and direction for continuity of seal through watertight transitions from wall expansion joint to other interfacing expansion joint systems at adjacent construction.
2. Product Data: Material description and application instructions.
3. Samples:
   a. Minimum [2 x 2] inch joint seal samples showing available colors of each product specified.
   b. Minimum [6] inch long samples [of each joint seal].

B. Informational Submittals:
1. Manufacturer's certification that:
   a. Products are capable of withstanding temperature of 150 degrees F (65 degrees C) for 3 hours while compressed to minimum of movement capability dimension without evidence of bleeding of impregnation medium from material.

b. Same material after heat stability test and after cooling to room temperature will self-expand to maximum of movement capability dimension within 24 hours at 68 degrees F (20 degrees C).

C. Sustainable Design Submittals: Refer to Division 01.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Minimum 10 years documented experience in production of specified materials.
2. Certified to ISO 9001 and 14001.

B. Installer Qualifications: Minimum 2 years documented experience in work of this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. In accordance with manufacturer's instructions.
B. Exercise proper care in handling of all work so as not to harm the finished surface, and take proper precautions to protect the work from damage after it is in place.
C. Store materials under cover in a dry and clean location off the ground.
D. Store adhesives, epoxies and resins at room temperature.
E. Remove materials that are damaged or otherwise not suitable for installation and replace with acceptable materials before handing over the completed work to the site authorities.
F. Installed assemblies should be identical to submitted and reviewed shop drawings, samples and certificates.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Contract Documents are based on products by Sika Emseal, 800-526-8365, www.emseal.com.

B. Substitutions: Refer to specification section 01 6000 Product Requirements.

2.2 MATERIALS

A. Exterior Wall Joint Seal:
1. Source: Seismic Colorseal by Sika Emseal.
2. Description: Silicone coated, ultraviolet resistant, watertight, primary wall seal with factory-applied adhesive on one side.
3. Form: Precompressed to less than nominal material size for installation into designed joint size equal to material nominal size.
4. Movement capability: Plus and minus 50% (total 100%) of nominal material size.
5. R-value: 2.15 per inch depth at nominal joint size compression, tested to ASTM C518.
6. STC rating: 52 in STC 56 wall, tested to ASTM E90.
7. OITC rating: 38 in OITC 38 wall, tested to ASTM E90.
8. Air permeability: Maximum 0.02 liter per second per square meter, tested to ASTM E283 at 75 Pa.
9. Water penetration: No water penetration, tested to ASTM E331 at 5000 Pa test pressure.
10. Wind loading:
    a. 0.1 mm net deflection, tested to ASTM E330 at 2730 Pa or 150 MPH wind.
    b. 0.6 mm net deflection, tested to ASTM E330 at 4854 Pa or 200 MPH wind.

11. Weathering: Sealing of outside wall joints per DIN 18542-1999 / G155-2013: Pass
12. VOC Emissions: CDPH-1.2-2017: Pass
13. Color: To be selected from Sika Emseal full color range.
14. Size: 2-3 inches
15. Silicone: Field applied corner bead at face of seal to substrate interface, furnished by joint seal manufacturer, in same material and color as used in factory coating.
    a. Abrasion Resistance: Less than 1% weight loss, tested to ASTM D4060
    b. Fuel Resistance: Pass, tested to ASTM C719/C1135

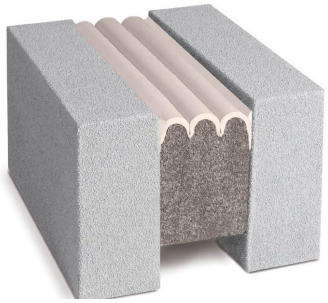
B. Roof Joint:

1. Roof Parapet Seal: Roof Parapet Joint RJ-0200, EMSEAL.COM
2. Horizontal Foam expansion, for use under the parapet joint seal: Horizontal Color seal, EMSEAL.COM
3. Description: dual-sealed, double-flanged, extruded thermoplastic rubber system for sealing exterior expansion joints in roofs. Watertightness achieved through positive integration with the roofing membrane and a purpose-designed system for transitioning between the joint in the roof and the joints in the walls.
4. Joint Thicknesses: 2-3 inches
5. Movement Capacity:
6. Color: White
7. Heat- weldable to be sealed with adjacent membrane roofing.

C. Floor Slab Joint:

1. Floor Seal: Horizontal ColorSeal, EMSEAL.COM
2. Floor Seal Metal cover plate: RFB Expansion joint, C-SGroup.com
3. Horizontal Foam expansion, for use in interior horizontal applications.

4. Joint thickness: 2-4 inches
5. Allows up to 100% movement.



D. Ceiling Joint:

1. Floor Seal: Migua Series, EMSEAL.COM
2. For use in in interior horizontal ceiling applications. Expansion joint assemblies to bridge 2-3" wide joint gaps comprising of L-shaped metallic anchorage units (rails) installed on both sides of the gap and a flexible rubber insert bridging the gap. The anchorage units should have perforations and are fastened to studs before drywall installation. Check that a profile of sufficient height is chosen to accommodate the wall finishes or drywall thickness. The top of the expansion joint rail can be used as a guide for installing wall finishes. Wall profiles should match with the profiles installed in interior floors providing a continuity of Expansion joint assemblies to bridge 2-3" wide joint gaps comprising of metallic anchorage units (rails) installed on both sides of the gap and a flexible rubber insert bridging the gap.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean joints thoroughly; remove loose and foreign matter that could impair adhesion or performance.

3.2 INSTALLATION

A. Install joint seal in accordance with Sika Emseal instructions and approved Shop Drawings.

B. Remove joint seal from precompressed packaging, immediately insert into joint, and allow to expand.

C. Use temporary retainers if required to maintain joint seals in position until expansion is complete.

END OF SECTION

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silyl-terminated polyether joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material.
4. Proposed test.
5. Number of samples required.

D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

F. Field-Adhesion-Test Reports: For each sealant application tested.

G. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
6. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Nonmembrane Roof Sealants: 300 g/L.
3. Single-Ply Roof Membrane Sealants: 450 g/L
4. Sealant Primers for Nonporous Substrates: 250 g/L.
5. Sealant Primers for Porous Substrates: 775 g/L
6. Modified Bituminous Sealant Primers: 500 g/L

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

C. Silicone, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability. nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.

D. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

E. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT.

F. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

G. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

H. Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

I. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

J. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

K. Silicone, M, P, 100/50, T, NT: Multicomponent, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade P, Class 100/50, Uses T and NT.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

C. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

D. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

E. Silicone, Nonstaining, M, NS, 50, NT: Nonstaining, multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

C. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

D. Urethane, S, P, 35, T, NT: Single-component, pourable, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 35, Uses T and NT.

E. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

F. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.

G. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.

H. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.

I. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.

J. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

K. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

2.5 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

C. STPE, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

2.6 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

2.7 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

2.8 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), or as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

a. Metal.
b. Glass.
c. Porcelain enamel.
d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile according to Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth according to Figure 8C in ASTM C1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

    a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

    a. Whether sealants filled joint cavities and are free of voids.
    b. Whether sealant dimensions and configurations comply with specified requirements.
    c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:

    a. Control and expansion joints in brick pavers.
    b. Isolation and contraction joints in cast-in-place concrete slabs.
    c. Joints between plant-precast architectural concrete paving units.
    d. Joints in stone paving units**,** including steps.
    e. Tile control and expansion joints.
    f. Joints between different materials listed above.
    g. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, M, P, 50, T, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Construction joints in cast-in-place concrete.
    b. Joints between plant-precast architectural concrete units.
    c. Control and expansion joints in unit masonry.
    d. Joints in dimension stone cladding.
    e. Joints in glass unit masonry assemblies.
    f. Joints in exterior insulation and finish systems.
    g. Joints between metal panels.
    h. Joints between different materials listed above.
    i. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
    j. Control and expansion joints in ceilings and other overhead surfaces.
    k. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

a. Isolation joints in cast-in-place concrete slabs.
b. Control and expansion joints in stone flooring.
c. Control and expansion joints in brick flooring.
d. Control and expansion joints in tile flooring.
e. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Tile control and expansion joints.
c. Joints on underside of plant-precast structural concrete beams and planks.
d. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: ***As selected by Architect from manufacturer's full range of colors***.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:

a. Control joints on exposed interior surfaces of exterior walls.
b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

G. Joint-Sealant Application: Concealed mastics.

1. Joint Locations:

a. Aluminum thresholds.
b. Sill plates.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Butyl-rubber based.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.
3. Interior custom hollow-metal doors and frames.
4. Exterior custom hollow-metal doors and frames.
5. Fire Rated hollow-metal doors and frames.

B. Related Requirements:

1. Section 082200 “FRP CleanroomDoors”
2. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

C. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.

D. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).

E. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

D. Field quality control reports.

1.8 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.9 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. (2.84 W/K x sq. m) when tested according to ASTM C518.

2.2 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches (44.5 mm).
c. Face**:** Uncoated steel sheet, minimum thickness of 0.042 inch (1.0 mm).
d. Edge Construction: Model 1, Full Flush.
e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Core: Manufacturer's standard.
g. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.

2. Frames:

a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Full profile welded.

3. Exposed Finish: Prime.

C. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3; SDI A250.4, Level A.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches (44.5 mm).
c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
d. Edge Construction: Model 1, Full Flush.
e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Core: Manufacturer's standard.
g. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.

2. Frames:

a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Full profile welded.

3. Exposed Finish: Prime.

D. Fire-Rated Doors: SDI A250.8, Level 3; SDI A250.4, Level A.
1. Doors:

a. Type: Fire Rated 90 min rated doors.
1) Tested in accordance with UL 10C and NFPA 252 (“positive pressure fire test”).
2) Provide units listed and labeled by UL (DIR) or ITS (DIR).
3) Attach fire rating label to each fire rated unit.
4) Smoke and Draft Control Doors (include with letter S on Drawings and/or Door Schedule: Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105 with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following:
a) Max air leakage: 3.0 cfm/ sq ft of door opening at .10 inch w.g. pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
b) Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
c) Label: Include the “S” label on fire- rating label of door.
b. Thickness: 1-3/4 inches (44.5 mm).
c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
d. Edge Construction: Model 1, Full Flush.
e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
h. Core: Manufacturer's standard Fire Rated Core.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B..

1. Doors:

    a. Type: As indicated in the Door and Frame Schedule.
    b. Thickness: 1-3/4 inches (44.5 mm).
    c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm), with minimum A40 (ZF120) coating.
    d. Edge Construction: Model 1, Full Flush.
    e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
    f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
    g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
    h. Core: Manufacturer's standard.
    i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.

2. Frames:

    a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
    b. Construction: Full profile welded.

3. Exposed Finish: Prime.

C. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3; SDI A250.4, Level A.

1. Doors:

    a. Type: As indicated in the Door and Frame Schedule.
    b. Thickness: 1-3/4 inches (44.5 mm).
    c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
    d. Edge Construction: Model 1, Full Flush.
    e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
    f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
    g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
    h. Core: Manufacturer's standard.
    i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.

2. Frames:

    a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
    b. Construction: Full profile welded.

3. Exposed Finish: Prime.

4. Frames:

   a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
   b. Construction: Full profile welded.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.5 MATERIALS

A. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. 7. Flat Topcoat Paints: VOC content of not more than 50 g/L.
8. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
9. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.

10. 13. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

H. Glazing: Comply with requirements in Section 088000 "Glazing."

2.6 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

4. Terminated Stops: Terminate stops 6 inches (152 mm) above finish floor with a 45-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in

extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.7 LOUVERS

A. Provide louvers for interior doors, where indicated, which comply with SDI 111, with blades or baffles formed of 0.020-inch- (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch- (0.8-mm-) thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
2. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other.
3. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.

B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, section 5.2
2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 CLEANING AND TOUCHUP

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 08 2200 – FRP CLEANROOM DOORS AND FIBERGLASS RESIN TRANSFER MOLDED DOOR FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes The Following:
   1. Fiberglass Reinforced Plastic (FRP) Doors and door shutter
   2. Fiberglass Resin Transfer Molded Door Frames
   3. Fiberglass Resign Molded Window Frames

1.2 RELATED SECTIONS

A. Related Sections Include The Following:
   1. Division 0 – Bidding and Contract Requirements
   2. Division 1 – General Requirements
   3. Division 8 – Finish Hardware
   4. Division 8 – Glazing

1.3 QUALITY ASSURANCE

A. Reference Standards

   1. Door Properties

      a) Standard test method for steady state thermal transmission properties by means of the heat flow meter apparatus.
      b) Successfully completed 1,000,000 cycles test in accordance with:

      AAMA 920-03 – Specification for Operating Cycle Performance of Side-Hinged Exterior Door Systems.
      ANSI A250.4-2001 – Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings.
      NWWDA TM-7 Test Method to Determine the Physical Endurance of Wood Doors and Associated Hardware Under Accelerated Operating Conditions.

      c) Additional Testing
      SFBC 3603.2 Forced Entry Test
      ASTM E 1886 Performance of Exterior Protective Systems
      ASTM E 1996 Impact Performance of Exterior Protective Systems
      ASTM C 518 Heat Transfer Properties of Materials
      ASTM D 1761 Mechanical Properties of Fasteners 1530 lb

   2. Laminate Properties

      Door face plate is a minimum of 0.125 inch thick fiberglass reinforced plastic molded into one continuous sheet starting with a 25 mil resin-rich gelcoat layer resin integrally molded with multiple layers

of 1.5 oz. sq ft fiberglass mat and one layer of 18 oz per square yard fiberglass woven roving saturated with special resin. Door plate weight shall not be less than 0.97 lbs per square foot at a ratio of 30/70 glass resin.

Laminated plate by itself evaluated in accordance with Florida Building Code TAS 201 Large Missile Impact Test as per ASTM-1996-05b, Standard Specification for Performance of Exterior Windows, Curtain Wall, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes. The missile (a 2 x 4 with a weight of 9 lbs shot from a cannon at a velocity of 50 ft/sec) did not penetrate the door face plate.

a) ASTM D 638 Tensile Strength Properties of Plastics
b) ASTM D 790 Flexural Strength Properties of Plastics 39,000 psi
c) ASTM D 2583 Indention Hardness of Plastics 53
d) ASTM D 256 Izod Pendulum Impact Resistance
e) ASTM D 792 Density/Specific Gravity of Plastics
f) ASTM D 1761 Mechanical Properties of Fasteners 1530 lb
g) ASTM E 84 Surface Burning Characteristics of Materials
h) ASTM G 155 Xenon Light Exposure of Non Metallic Materials
i) ATSM D 635 Method For Rate of Burning
j) ASTM D 2843 Smoke Density
k) ASTM D 1929 Self Ignition Temperature Properties
l) SFBC PA 201 Impact Procedures for Large Missile Impact

3. Core Properties

a) ASTM C 177 Thermal Properties of Materials
b) ASTM D 1622 Density and Specific Gravity
c) ASTM E 84 Surface Burning Characteristics of Materials
d) WDMA TM-10 and TM-5 Firestop ASTM E 152 U.L 10(b)
e) ASTM E90-04- Sound Transmission Loss
f) ASTM E413-04 Classification for Rating Sound Insulation
g) ASTM E1332-90 Standard Classification for Determination of Outdoor-Indoor Transmission Class
h) ASTM E2235-04 Standard Test for Determination of Decay Rates for Use in Sound Insulation Methods

B. Qualifications

1. Manufacturer Qualifications: A company specialized in the manufacture of fiberglass reinforced plastic (FRP) doors and frames as specified herein with a minimum of 30 years documented experience and with a record of successful in-service performance for the applications as required for this project.
2. Installer Qualifications: An experienced installer who has completed fiberglass door and frame installations similar in material, design, and extent to those indicated and whose work has resulted in construction with a record of successful in-service performance.
3. Source limitations**:** Obtain fiberglass reinforced plastic doors and resin transfer molded fiberglass frames through one source fabricated from a single manufacturer, including fire rated fiberglass

frames. This ensures complete uniformity of physical properties and consistency in the resin chemistry tailored for this application.

4. Source limitations: Hardware and accessories for all FRP doors as specified in Section 08710 shall be provided and installed by the fiberglass door and frame manufacturer.
5. Source Limitations: Glass for windows in doors shall be furnished and installed by door and frame manufacturer in accordance with related section, Division 8, Glazing.

1.4 SUBMITTALS

A. Product Technical Data Including:
   1. Acknowledgment that products submitted meet requirements of standards referenced.
   2. Manufacturer shall provide certificate of compliance with current local and federal regulations as it applies to the manufacturing process.
   3. Manufacturer's installation instructions.
   4. Schedule of doors and frames indicating the specific reference numbers used on the owner's project documents, noting door type, frame type, size, handing and applicable hardware.
   5. Details of core and edge construction. including factory construction specifications.
   6. Certification of manufacturer's qualifications.

B. Submittal Drawings for Customer Approval Shall be Submitted Prior to Manufacture and Will Include the Following Information and Formatting:
   1. Summary door schedule indicating the specific reference numbers as used on owner's drawings, with columns noting door type, frame type, size, handing, accessories and hardware.
   2. A drawing depicting front and rear door elevations showing hardware with bill of material for each door.
   3. Drawing showing dimensional location of each hardware item and size of each door.
   4. Individual part drawing and specifications for each hardware item and FRP part or product.
   5. Construction and mounting detail for each frame type

C. Samples:
   1. Provide one complete manufactured door sample which represents all aspects of the typical manufacturing process, including molded in gelcoat color and face plate construction. One edge should expose the interior of the door depicting the unique u-shaped continuous piece stile and rail, hardware reinforcement and core material.
   2. Color Chips, min 4"x6" of each color selected by Owner, for review and selection.

D. Operation and Maintenance Manual
   1. Include recommended methods and frequency for maintaining optimum condition of fiberglass doors and frames under anticipated traffic and use condition.
   2. Include one set of final as built drawings with the same requirements as mentioned in Section B above.
   3. Include certificate of warranty for door and frame listing specific door registration numbers.
   4. Include hardware data sheets and hardware manufacturer's warranties.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Each door and frame shall be delivered individually crated for protection from damage in cardboard containers, clearly marked with project information, door location, specific reference number as shown on

drawings, and shipping information. Each crate shall contain all fasteners necessary for installation as well as complete installation instructions.

1. Doors shall be stored in the original container on edge, out of inclement weather for protection against the elements.
2. Handle doors pursuant to the manufacturer's recommendations as posted on outside of crate.

1.6 WARRANTY

A. All fiberglass doors and frames have a lifetime guarantee against failure due to corrosion. Additionally, fiberglass doors and fiberglass frames are guaranteed for ten years against failure due to materials and workmanship, including warp, separation or delamination, and expansion of the core.
B. On site assistance available.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Corrim, www.corrim.com
B. Chem-Pruf Door Co.,: www.chem-pruf.com
C. Substitutions: See section 01 6000 Product Requirements

2.2 FRP DOORS

A. **Doors and door window shutters:** shall be made of fiberglass reinforced plastic (FRP) using Class 1 premium resin with no fillers that is specifically tailored to resist chemicals and contaminants typically found in food processing applications.
    a. Doors shall be 1 ¾ inch thick and of flush construction, having no seams or cracks. All doors up to 4'0 x 8'0 shall have equal diagonal measurements.
    b. For consistency in the resin chemistry tailored for this application and to maintain the same physical properties throughout the structure, all fiberglass components including face plates, stiles and rails and frames must be fabricated by the same manufacturer. Components obtained through various outside sources for plant assembly will not be accepted.
    c. Color: To be selected by Owner from manufacturers full range of standard colors.

B. **Door Plates:** Shall be 0.125 inch thick minimum, molded in one continuous piece, starting with 25 mil gel-coat of the color specified, integrally molded with multiple layers of 1.5 ounces per square foot fiberglass mat and one layer of 18 ounce per square yard fiberglass woven roving.
    a. Each layer shall be individually laminated with resin as mentioned above.
    b. Door plate weight shall not be less than 0.97 lbs per square foot at a ratio of 30/70 glass to resin. Plate alone to withstand Large Missile Impact per FBC TAS 201.
    c. Face plates manufactured using the pultrusion process does not allow for a smooth molded gel-coat finish, the use of woven roving for adequate plate thickness, strength and weight, or the appropriate glass to resin ratio and will not meet the quality standards of this project.

C. **Stiles and Rails:** Shall be constructed starting from the outside toward the inside, with a matrix of at least three layers of 1.5 ounce per square foot of fiberglass mat.
    a. The stile and rail shall be molded in one continuous piece to a U-shaped configuration and to the exact dimensions of the door. In this manner there will be no miter joints and disparate materials used to form the one-piece stile and rail.

D. **Core** materials option to be:
- Polypropylene plastic honeycomb core with a non woven polyester veil for unparalleled plate bonding, 180 PSI typical compression range.
- 2 PSF expanded polyurethane foam core, which completely fills all voids between the door plates. Foam properties ASTM E-84 comply with IBC Code.
- As specifically requested.

E. **Internal Reinforcement** shall be a dense matrix of cloth glass fibers and premium resin with a minimum hinge screw holding value of 1000 lbs per screw.

F. **Finish** of door frame shall be identical with 25 mil resin-rich gelcoat of the specified color integrally molded in at time of manufacture resulting in a smooth gloss surface that is dense and non-porous. To achieve optimum surface characteristics, the gelcoat shall be cured within a temperature range of 120F to 170F creating an impermeable outer surface, uniform color throughout, and a permanent homogeneous bond with the resin/fiberglass substrate beneath. Only the highest quality gelcoat will be used to ensure enduring color and physical properties. Paint and/or post application of gelcoat result in poor mechanical fusion and will be deemed unacceptable for this application. The finish of the door and frame must be field repairable without compromising the integrity of the original uniform composite structure, function or physical strength.

G. **Window** openings shall be provided for at time of manufacture and shall be completely sealed so that the interior of the door is not exposed to the environment. Fiberglass retainers, which hold the glass in place shall be resin transfer molded with a profile that drains away from glazing. The window and window retainer must match in color and finish with 25 mil of resin-rich gelcoat integrally molded at time of manufacture. Mechanical fasteners shall not be used to attach retainers. Glass, as specified herein, shall be furnished and installed by door and frame manufacturer. In order to maintain uniform appearance, product longevity and the corrosion resistance this application requires, window retainers fabricated from Metal, PVC or Vinyl will not be accepted.

H. Window Style and Window Cover Option:

    a. Window Pharmaceutical Style (Molded Design)
    b. Window Cover shutter FRP material (Flush with door surface when in closed position; stays open in place by proprietary design).

H. **Louver** openings shall be completely sealed so that the interior of the door is not exposed to the environment. Louvers are to be solid fiberglass “V” Vanes and shall match the color and finish of the door plates.

I. **Transoms** shall be identical to the doors in finish, construction, materials, thickness and reinforcement.

J. Door shall meet Forced Entry test pursuant to FBC requirement SFBC 3603.2 300 lb test.

2.3 FRP FRAMES

A. **Frames** (rated and non-rated) shall be fiberglass and manufactured using the resin transfer method creating one solid piece (no voids) with complete uniformity in color and size. Beginning with a minimum 25 mil gelcoat layer molded in and a minimum of two layers of continuous strand fiberglass mat saturated with resin, the frame will be of one-piece construction with molded stop. All frame profiles shall have a core material of 2 psf polyurethane foam. Metal frames or pultruded fiberglass frames will not be accepted.

B. **Finish** of frame shall be identical to the door with 25 mil resin-rich gelcoat of the specified color integrally molded in at time of manufacture. To achieve optimum surface characteristics, the gelcoat shall be cured within a temperature range of 120F to 170F creating an impermeable outer surface, uniform color throughout, and a permanent homogeneous bond with the resin/fiberglass substrate beneath. Only the highest quality gelcoat will be used to ensure enduring color and physical properties. Paint and/or post application of gelcoat result in poor mechanical fusion and will be deemed unacceptable for this application. The finish of the door and frame must be field repairable without compromising the integrity of the original uniform composite structure, function or physical strength.

C. **Jamb/Header** connection shall be mitered for tight fit. Optional seamless one piece frame construction as indicated on the project schedules and related details.

D. **Internal Reinforcement** shall be continuous within the structure to allow for mounting of specified hardware. Reinforcing material shall be a dense matrix of cloth glass fibers and premium resin with a minimum hinge screw holding value of 1000 lbs per screw. All reinforcing materials shall be completely encapsulated. Documented strength of frame screw holding value after third insert must be submitted. Dissimilar materials, such as steel, will be deemed unacceptable as reinforcement for hardware attachment.

E. **Mortises** for hardware shall be accurately machined by **CNC** to hold dimensions to +/- 0.010 inch in all three axis.

F. **Hinge pockets** shall be accurately machined by CNC to facilitate heavy duty hinges at all hinge locations, using shims when standard weight hinges are used.

2.4 HARDWARE

A. See Section 08710

B. The special nature of this material requires that all related hardware as specified must be furnished and installed by the door frame manufacturer to maintain product quality and function as well as to ensure sufficient support/reinforcement, precision tooling and proper sealing methods are provided.

PART 3 – EXECUTION

3.1 INSTALLATION CONDITIONS

A. Verification of Conditions
   1. Verify openings are correctly prepared to receive doors and frames.
   2. Verify openings are correct size and depth in accordance with submittal drawings.

B. Installer's Examination
   1. Door installer shall examine conditions under which construction activities of this section are to be performed and submit a written report to general contractor if conditions are unacceptable.
   2. General Contractor shall submit two copies of the installer's report to the architect within 24 hours of receipt.
   3. Installer shall not proceed with installation until all unacceptable conditions have been corrected.

3.2 INSTALLATION

A. Door shall be delivered at job site individually crated. Each crate to be clearly marked with the specific opening information for quick and easy identification.

B. All single doors to be shipped completely assembled in the frame with hardware installed. Double doors to be prehung at the factory to ensure a proper fit and that hardware functions properly, then broken down for shipping purposes. If unitization is not provided by manufacturer, installation of door and

C. Install door opening assemblies in accordance with shop drawings and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.

D. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.

E. Site tolerances: Maintain plumb and level tolerance specified in manufacturer's printed installation instructions.

F. Fire labeled doors and frames must be installed in strict accordance with manufacturer's instructions and the latest revision of NFPA 80.

3.3 ADJUSTING

A. Adjust doors in accordance with the door manufacturer's maintenance instructions to swing open and shut without binding and to remain in place at any angle without being moved by gravitational influence.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instruction.

3.4 CLEANING

A. Clean surfaces of door opening assemblies and exposed door hardware in accordance with respective manufacturer's maintenance instructions.

3.5 PROTECTION OF INSTALLED PRODUCTS

A. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

End of Section

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

B. Related Requirements:

1. Section 077200 "Roof Accessories" for roof hatches.

1.3 ALLOWANCES

A. Access doors and frames are part of an access door and frame allowance.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details**,** fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.

C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspecting agency.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.

1.6 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.7 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Concealed Flanges :
1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
2. Locations: Wall or Ceiling.
3. Door Size: as indicated on the Drawings.
4. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primed.
5. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage factory primed.
6. Frame Material: Same material and thickness as door.
7. Latch and Lock: Cam latch, screwdriver operated.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Concealed Flanges :
1. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
2. Locations: Wall or Ceiling.
3. Door Size: as indicated on the Drawings.
4. Fire-Resistance Rating: Not less than that indicated>.
5. Temperature-Rise Rating: 450 deg F (250 deg C) at the end of 30 minutes.
6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage, factory primed.
7. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch (1.02 mm), 20 gage, factory primed.
8. Frame Material: Same material, thickness, and finish as door.
9. Latch and Lock: Self-closing, self-latching door hardware, operated by knurled-knob.

2.4 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063.

E. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

F. Frame Anchors: Same material as door face.

G. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.5 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.

E. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.
3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in Section 087100 "Door Hardware."

F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil (0.025 mm) for topcoat.

a. Color: As selected by Architect from full range of industry colors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 08 41 13 – ALUMINUM-FRAMED ENTRANCE AND STOREFRONT

PART 1 – GENERAL

1.01 SUMMARY

A. Related Documents: Conditions of the Contract, Division 1 – General Requirements, and Drawings apply to Work of this Section.

B. Section Includes:
   1. Storefront framing, complete with reinforcing, fasteners, anchors, and attachment devices.
   2. Storefront doors, complete with reinforcing for hardware requirements.
   3. Accessories necessary to complete the work.

C. Related Sections:
   1. Section 01 40 00 – Quality Requirements
   2. Section 01 81 13 Sustainable Design Requirements – LEED v4 BD+C
   3. Section 05 50 00 – Metal Fabrications.
   4. Section 07 92 00 – Joint Sealants
   5. Section 08 51 13 – Aluminum Windows
   6. Section 08 71 00 – Door Hardware
   7. Section 08 81 00 – Glass Glazing

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45 Designation System for Aluminum Finishes.

B. American Architectural Manufactures Association (AAMA):
   2. 501 Methods of Test for Exterior Walls.
   3. 501.2 Quality Assurance and Diagnostic Water Leakage Field Check of installed Storefront, Curtain Walls, and Sloped Glazing Systems.
   4. 611 Voluntary Specification for Anodized Architectural Aluminum
   5. 701 Voluntary Specifications for Pile Weather-stripping and Replaceable Fenestration Weather seals.
   6. 1503 Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
   7. CW-10 Care and handling of Architectural Aluminum from Shop to Site.
   8. SFM-1 Aluminum Storefront and Entrance Manual.

C. American Society for Testing and Materials (ASTM)
   9. B209 Aluminum and Aluminum – Alloy Sheet and Plate
   10. B221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
   11. E283 Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors.
   12. E330 Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
   13. E331 Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

D. Glass Association of North America (GANA):
   1. Glazing Manual.

1.03 SYSTEM REQUIRMENTS

A. Design Requirements
   1. Provide aluminum entrance and storefront systems capable of withstanding loads and thermal and structural movement requirements indicated without failure, based on testing manufacturer's standard units in assemblies similar to those indicated for this project. Failure includes the following:
      A. Air infiltration and water penetration exceeding specified limits.

   B. Framing members transferring stresses, including those caused by thermal and structural movement, to glazing units.
2. Drawings are diagrammatic and do not purport to identity nor solve problems of thermal of structural movement, glazing, anchorage, or moisture disposal.
3. Requirements shown by details are intended to establish basic dimension of units, sight lines and profiles of members.
4. Provide concealed fastening whenever possible.
5. Provide entrance and storefront systems, including necessary modifications, to meet specified requirements and maintaining visual design concepts.
6. Attachment considerations are to take into account site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening, or fracturing connection between units and building structure or between units themselves.
7. Anchors, fasteners and braces shall be structurally stressed not more than 50% of allowable stress when maximum loads are applied.
8. Provide for expansion and contraction due to structural movement without detriment to appearance or performance.
9. Framing systems shall accommodate expansion and contraction movement due to surface temperature differentials of 180 degrees F without causing buckling, stress on glass, failure of joint seals, excessive stress on structural elements, reduction of performance, or other detrimental effects.

B. Performance Requirements:
1. Wind loads: provide framing systems, including anchorage, capable of withstanding wind-load design pressures calculated according to requirements of authorities having jurisdiction or the American Society of Civil Engineers' ASCE 7, "Minimum Design Loads for Buildings and Other Structures," 6.4.2, "Analytical Procedure," whichever are more stringent.
2. Air infiltration: Air leakage through fixed light areas of storefront shall not exceed 0.06 cfm per square foot of surface area when tested in accordance with ASTM E283 at differential static pressure of 6.24 psf.
3. Water infiltration: No uncontrolled leakage when tested in accordance with ASTM E331 at test pressure of 8 psf as defined in AAMA 501.
4. Static-Pressure Test Performance: Provide entrance and storefront systems that do not evidence material failures, structural distress, failure of operating components to function normally, or permanent deformation of main framing members exceeding 0.2 percent of clear span when tested according to ASTM E330.
5. Seismic Loads: Provide entrance and storefront systems, including anchorage, capable of withstanding the effects of earthquake motions calculated according to requirements of authorities having jurisdiction or ASCE 7, "Minimum Design Loads for Building and Other Structures," and "Earthquake Loads," whichever are more stringent.
6. Dead Loads: Provide entrance and storefront system members that do not deflect an amount which will reduce glazing bite below 75 percent of design dimension when carrying full dead load.
   A. Provide a minimum 1/8 inch clearance between members and top of glazing or other fixed part immediately below.
   B. Provide a minimum 1/16 inch clearance between members and doors.
7. Deflection: Maximum calculated deflection of any framing member in direction normal to plane of wall when subjected to specified design pressures for spans up to and including 13'-6" shall be limited to [1/175] of its clear span and for spans greater than 13'-6" deflection shall be limited to [1/240] of its clear span + 1/4", except that maximum deflection of members supporting plaster surfaces shall not exceed 1/360 of its span.
8. Average Thermal Conductance: Provide storefront systems with average U-values of not more than 0.63 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.1.
9. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than 45.

C. Testing Requirements: provide components that have been previously tested by an independent testing laboratory.

1.04 SUBMITTALS

A. General: Submit in accordance with Section 01 30 00 – Submittal Procedures.

B. Product Data:
   1. Submit manufacturer's descriptive literature and product specifications.
   2. Include information for factory finishes, hardware, accessories, and other required components.
   3. Include color charts for finish indicating manufacturer's standard colors available for selection.

C. LEED Submittals:
   1. Product Data for Credit MR: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   2. Product Data for Credit IEQ: For adhesives and sealants used inside the weatherproofing system, including printed statement of VOC content.

D. Shop Drawings:
   1. Submit shop drawings covering fabrication, installation and finish of specified systems.
   2. Include following:
      a. Fully dimensioned elevation drawing with details coordination keys.
      b. Locations of exposed fasteners and joints.
   3. Provide detailed drawings of:
      a. Composite members.
      b. Joint connections for framing systems and for entrance doors.
      c. Anchorage.
      d. System reinforcements
      e. System expansion and contraction provisions.
      f. Glazing methods and accessories.
      g. Internal sealant requirements.
      h. Thermal improvements.
   4. Schedule of finishes

D. Samples:
   1. Submit manufacturer's standard samples indicating quality of finish.
   2. Where normal texture or color variations are expected, include additional samples illustrating range of variation.

E. Test Reports:
   1. Standard systems: Submit certified copies of previous test reports substantiating performance of system in lieu of retesting. Include other supportive data as necessary.

F. Qualification Data:
   1. Submit certification from storefront manufacturer verifying installer's qualifications, and verifying that installer has the required five years minimum experience installing aluminum-framed entrance and storefront systems.

G. Manufacturer's instructions: Submit manufacturer's printed installation instructions.

H. Sealant Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating that the materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with sealants; include joint sealant manufacturer's written interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion

1.05 QUALITY ASSURANCE

A. Single Source Responsibility:
   1. To ensure quality of appearance and performance, obtain materials for systems from either a single manufacturer or from manufacturer approved by systems manufacturer.

A. Installer Qualifications: Certified in writing by system manufacturer as qualified for installation of specified systems.

1. Engineering Responsibility: Installer shall assume engineering responsibility and shall prepare data for entrance and storefront systems, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this project.

B. Perform work in accordance with AAMA SFM-1 and manufacturer's written instructions.
C. Manufacturer's representatives shall inspect final installation and provide a written report of acceptance to be included with storefront installer's closeout documents.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Sections 01 60 00 – Product Requirements
B. Protect finished surfaces as necessary to prevent damage.
C. Do not use adhesive papers or sprayed coatings that become firmly bonded when exposed to sun.
D. Do not leave coating residue on any surfaces.
E. Replace damaged units.

1.07 Warranty

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract.
B. Provide written warranties in form acceptable to Owner signed by manufacturer, installer and General Contractor, as follows:
   1. Manufacturer's Warranty shall cover the following:
      a) Structural failures including, but not limited to, excessive deflection.
      b) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      c) Defective materials, defective manufacture, or glass breakage due to defective design.
      d) Failure of operating components to function normally.
      e) Agreement to replace components which fail within 2 years from date of Substantial Completion.
   2. Installer's Warranty shall cover the following:
      f) All items listed above under Manufacturer's Warranty.
      g) Water leakage through fixed glazing and frame areas.
      h) Defective installation workmanship, or glass breakage due to defective installation.
   3. General Contractor's Warranty shall cover the following:
      i) Items a) through d) listed above under Manufacturer' Warranty.
      j) Items f) through h) listed above under Installer's Warranty.
      k) Agreement to provide materials and labor for replacement of defective components that fail within 2 years from date of Substantial Completion.
C. Warranty response time: The aluminum storefront installer shall respond to requests for warranty repairs within 24 hours of receiving notice that such repairs are required.

PART 2 – PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS

A. Subject to compliance with requirements indicated, provide products by one of the following:
   1. Oldcastle Building Envelope.
   2. Kawneer Company.
   3. Tubelite, Inc.

B. No Substitutions.

C. Acceptable storefront framing system for exterior use: (2"x 4 ½" center glazed storefront):
   1. Oldcastle Series 3000 Thermal Multiplane.
   2. Kawneer VG451T.
   3. Tubelite T14000
   4. Storefront framing system must be conventionally center glazed. Offset, or structural, glazing systems are not acceptable.

D. Acceptable storefront framing system for interior use: (1-3/4"x 4-1/2" center glazed storefront) (Interior storefront doors and framing systems shall have the same gage aluminum and same structural construction as the exterior systems.):
   1. Oldcastle Series 2000 framing.
   2. Kawneer Trifab 450.
   3. Tubelite E4500 series.

E. Acceptable entrance door systems:
   1. Door construction: 2 inch overall thickness with minimum .188 inch thick extruded aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
   2. Door design: Shall be Wide Stile with smooth surface, minimum 10" high, bottom rails and at least one intermediate mid-panel. Door top rail to be a minimum of 7" high for closer mounting. Mid-panel height to be coordinated with hardware requirements, specifically to be centered on exit devices, regardless of the dimensions shown on the drawings. Doors with full glass lites are not acceptable. Door height to be no taller than 7'-0".
   3. Door labeling: Doors shall have permanent labels on the hinge edge surface identifying the door manufacturer.
   4. Glazing stops and gaskets: Shall be snap-on, extruded aluminum stops and preformed gaskets. Provide non-removable glass stop to exterior of door.
   5. Door stops: Shall be integral to the door frame extrusion. Door stop must be a minimum of ½" high x 1" deep. Fin type, snap in, or screw applied door stops are not acceptable. Door stops must provide uninterrupted weathering the entire length of the stop.
   6. Reinforcing and Anchoring: Doors and door frames are to be properly reinforced with 1/4" min. thickness internal steel back up material sufficient for attaching hardware as specified. In addition to steel reinforcing, door frame extrusion is to be non-thermally broken with 3/16" minimum wall thickness for hardware mounting with integral door stops as part of the extrusion. Types of hardware include, but are not limited to: surface mounted door closers, handicap operators, hold open arms, lock or latch strikes, removable mullions, hinges or pivots, and any other hardware as called out in the finish hardware section of the specifications. Hardware must be anchored to the main sections of the storefront door or door frame and no hardware will be anchored into any snap on extrusion.
   7. Hardware reinforcement for hinging to run continuous the full length of the door jamb. Hardware reinforcement for lock strikes and closers to be a minimum of 16" in length and located within the door and frame to accommodate the specified hardware.
   8. Door frames: Only aluminum, wood, or fiberglass doors are to be installed in aluminum door frames. Do not install hollow metal doors in aluminum door frames.
   9. Door frame, and reinforcement requirements, described above, apply to both interior and exterior aluminum door frames. Door frames must be able to accommodate doors that are 1-3/4" or 2" thick as called for on the drawings, or in the specifications.

2.02 FRAMING MATERIALS AND ACCESSORIES

A. Aluminum:
   1. ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 5005-H16 for sheets; or other alloys and temper recommend by manufacturer appropriate for specified finish.

B. Internal Reinforcing:
   1. ASTM A36 for carbon steel.
   2. Shapes and sizes to suit installation.
   3. Steel components factory coated with alkyd type zinc chromate primer complying with FS TT-P-645.

C. Anchorage Devices:
   1. Manufacturer's standard formed or fabricated steel or aluminum assemblies of shapes, plates, bars or tubes.
   2. Hot-dip galvanized steel assemblies after fabrication; comply with ASTM A123, 2.0 ounce minimum coating.

D. Fasteners:
   1. Aluminum, non-magnetic stainless steel or other non-corrosive materials compatible with items being fastened.
   2. Provide concealed fasteners wherever possible.
   3. For exposed locations, provide Phillips flathead screws with finish matching item fastened.
   4. For concealed locations, provide manufacturer's standard fasteners.

E. Expansion Anchor Devices: lead-shield or toothed-steel, drilled-in, expansion bolt anchors.

F. Protective Coatings: Cold-applied asphalt mastic complying with SSPC, compounded for 30 mil thickness for each coat; or alkyd type zinc chromate primer complying with FS TT-P-645

G. Touch-Up primer for galvanized components: zinc oxide conforming with FS TT-P-641

H. Glazing Gaskets:
   1. Compression type design, replaceable, molded or extruded, of neoprene, polyvinyl chloride (PVC), or ethylene propylene diene monomer (EPDM).
   2. Profile and hardness as required to maintain uniform pressure for watertight seal.

I. Weatherproofing:
   1. Wool pile conforming to AAMA 701.2.

J. Internal Sealants and Baffles.

K. Adhesives and Sealants: Provide adhesives and sealants inside the weatherproofing system containing VOC content of 250g/L, or less when calculated according to 40CFR 59, Subpart D (EPA Method 24).

2.03 GLASS AND GLAZING

A. Refer to Section 08 80 00 – Glazing.

2.04 FABRICATION

A. Coordination of Fabrication
   1. Check actual frame or door openings required in construction work by accurate field measurements before fabrications.
   2. Fabricate units to withstand loads that will be applied when system is in place.

B. General
   1. Conceal fasteners wherever possible.
   2. Reinforce work as necessary for performance requirements, and for support to structure.
   3. Separate dissimilar metals and aluminum in contact with concrete utilizing protective coating or preformed separators, which will prevent contact and corrosion.
   4. Comply with Section 08 80 00 – Glazing, for glazing requirements.

C. Aluminum Framing
   1. Provide members of size, shape and profile indicated, designed to provide for glazing from the exterior at the first level or ground floor level. Glaze system from the interior at any locations above the first level.
   2. Provide manufacturer's standard thermal break between exterior and interior aluminum surfaces.

3. Fabricate frame assemblies with joints straight and tight fitting. Doors and door frames are to be shop fabricated. Field fabrication of frames will not be allowed.
4. Reinforce internally with structural members as necessary to support design loads.
5. Maintain accurate relation of planes and angles, with hairline fit of contacting members.
6. Seal horizontals and direct moisture accumulation to exterior.
7. Provide flashings and other materials used internally or externally that are corrosive resistant, not-straining, non-bleeding and compatible with adjoining materials.
8. Provide manufacturer's extrusions and accessories to accommodate expansion and contraction due to temperature changes without detrimental to appearance or performance.
9. Provide storefront manufacturer's standard high performance extruded sill flashing at all storefront framing.
10. Fabricate door frames to accept specified hardware without compromising the weather seal around doors.

D. Welding
1. Comply with recommendations of the American Welding Society.
2. Use recommended electrodes and method to avoid distortion and discoloration.
3. Grind exposed welds smooth and flush with adjacent surfaces; restore mechanical finish.

E. Flashings: Form from sheet aluminum with same finish as extruded sections, unless otherwise noted. Apply finish after fabrication. Material thickness as required to suit condition without deflection or "oil-canning".

2.05 FINISHES

A. Clear Anodized:
1. Conforming to AA-M12C22A31 and AAMA 611.
2. Architectural Class II, etched, medium matte, clear anodic coating, 0.4 mil minimum thickness

OR

B. Color Anodized
1. Conforming to AAMA 601, and either AA-M12C22A44 or AAM10C21A44.
2. Architectural Class [1], etched, medium matte, [black] [dark bronze] [medium bronze] [light bronze] colored anodic coating, [0.7] mil minimum thickness.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine conditions and proceed with Work in accordance with Section 01 40 00 – Quality Requirements.

3.02 INSTALLATION

A. General: Comply with manufacturer's written instructions for protecting, handling, and installing entrance and storefront systems. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Seal joints watertight.

B. Erection Tolerances:
1. Limit variations from plumb and level:
a. 1/8 inch in 10'-0" vertically.
b. 1/8 inch in 20'-0" horizontally.
2. Limit variations from theoretical locations; 1/4 inch for any member at any location.
3. Limit offsets in theoretical end-to-end and edge-to-edge alignment: 1/16 inch from flush surfaces not more than 2 inches apart or out-of-flush by more than 1/4 inch.

C. Install doors and hardware in accordance with manufacturer's printed instructions.

D. Set units plum, level and true to line, without warp or rack of frame.

E. Anchor securely in place, allowing for required movement, including expansion and contraction.

F. Separate dissimilar materials at contact points, including metal in contact with masonry or concrete surfaces, with bituminous paint or preformed separators to prevent contact with masonry of concrete.

G. Set sill members in bed of sealant. Set other members with internal sealants and baffles to provide weather-tight construction.
H. Coordinate installation of perimeter sealant and backing materials between assemblies and adjacent construction in accordance with requirements of Section 07 92 00 – Joint Sealants.
I. Glazing: refer to requirements of Section 08 81 00 – Glass Glazing.

3.03 ADJUSTING

A. Test door operating function. Adjust closing and latching speeds and other hardware in accordance with manufacturer's instructions to ensure smooth operation.

3.04 CLEANING

A. Clean surfaces in compliance with manufacturer's recommendations; remove excess mastic, mastic smears, foreign materials and other unsightly marks.
B. Clean metal surfaces exercising care to avoid damage.

3.05 PROTECTION

A. Provide final protection and maintain conditions, acceptable to manufacturer and installer that ensure entrance and storefront systems are without damage or deterioration at Substantial Completion.

END OF SECTION

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding doors.
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.

3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.
b. Manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.
h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

D. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Seven years for heavy duty cylindrical (bored) locks and latches.
3. Five years for exit hardware.
4. Five years for manual overhead door closer bodies.
5. Twenty five years for manual overhead door closer bodies.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

   a. Two Hinges: For doors with heights up to 60 inches.
   b. Three Hinges: For doors with heights 61 to 90 inches.
   c. Four Hinges: For doors with heights 91 to 120 inches.
   d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

   a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
   b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

   a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
   b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

   a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

   a. McKinney (MK).

B. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 certified pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed

stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

    a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
    b. Pemko (PE).

C. Pivots: ANSI/BHMA A156.4, Grade 1, certified. Space intermediate pivots equally not less than 25 inches on center apart or not more than 35 inches on center for doors over 121 inches high. Pivot hinges to have oil impregnated bronze bearing in the top pivot and a radial roller and thrust bearing in the bottom pivot with the bottom pivot designed to carry the full weight of the door. Pivots to be UL listed for windstorm where applicable.

1. Manufacturers:

    a. Norton Rixson (RF).

2.3 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

    a. Rockwood (RO).

B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:

    a. Rockwood (RO).

C. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.

3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

5. Manufacturers:

    a. Rockwood (RO).

2.4 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

C. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Manufacturer’s Standard.

D. Removable Cores: Provide removable cores as specified, core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

E. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

F. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).
4. Construction Control Keys (where required): Two (2).
5. Permanent Control Keys (where required): Two (2).

G. Construction Keying: Provide temporary keyed construction cores.

H. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.5 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).
b. MMF Industries (MM).
c. Telkee (TK).

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Where specified, provide status indicators with highly reflective color and wording for “locked/unlocked” or “vacant/occupied” with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1” x 0.6” with a curved design allowing a 180 degree viewing angle with protective covering to prevent tampering.

2. Manufacturers:

a. Yale Commercial(YA) - 8800FL Series.

2.7 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.8 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

   a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
   b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

6. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.

8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

9. Rail Sizing: Provide exit device rails factory sized for proper door width application.

10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:

a. Von Duprin (VD) - 35A/98 XP Series.

2.9 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Manufacturers:

a. LCN Closers (LC) - 4040 Series.
b. Norton Rixson (NO) - 7500 Series.

C. Door Closers, Overhead Concealed (Narrow Profile): ANSI/BHMA 156.4 Grade 1 Certified Products Directory (CPD) listed door closers designed for narrow profile frames and doors. Closers to have fully concealed body in the frame head for offset hung applications, with separate and independent valves for closing speed and backcheck adjustments and a decorative cover plate.

1. Manufacturers:

a. Norton Rixson (RF) - 91DCP Series.

2.10 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:

a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

6. Manufacturers:

a. Rockwood (RO).

2.11 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

a. Rockwood (RO).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

a. Norton Rixson (RF).

2.12 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. Pemko (PE).

2.13 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.14 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.

2. The supplier is responsible for handing and sizing all products.

3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. MR - Markar
3. RF - Rixson
4. RO - Rockwood
5. YA - Yale
6. VD - Von Duprin

7. NO - Norton
8. PE - Pemko
9. OT - Other

Hardware Schedule – In progress

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Glass and plastic glazing.

B. Glazing compounds and accessories.

C. Mirrors

1.02 RELATED SECTIONS

A. Section 07 92 00 - Joint Sealers: Sealant and Backings.

B. Section 08 11 13 – Hollow Metal Doors and Frames.

C. Section 08 14 16 - Flush Wood Doors: Glazed doors.

D. Section 08 51 13 - Aluminum Windows: Operable and Fixed Glazed Windows.

E. Section 10 28 00 - Toilet, Bath, and Laundry Accessories: Mirrors.

1.03 REFERENCES

A. ASTM C 864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 1993.

B. ASTM C 1036 - Standard Specification for Flat Glass; 1991 (Reapproved 1997).

C. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass; 1992.

D. ASTM C 1193 - Standard Guide for Use of Joint Sealants; 1991 (Reapproved 1995).

E. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference; 1996.

F. GANA (GM) - GANA Glazing Manual; Glass Association of North America; 1997.

G. GANA (SM) - FGMA Sealant Manual; Glass Association of North America; 1990.

1.04 PERFORMANCE REQUIREMENTS

A. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:

1. In conjunction with materials described in Section 072100 and 079200.
2. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

B. Select thickness of exterior glass to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with 2003 IBC code.

1. Test in accordance with ASTM E 330.
2. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
3. Thicknesses listed are minimum.

1.05 SUBMITTALS

A. See Section 013300 – Submittal Procedures.

C. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

D. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.

E. Certificates: Certify that products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with GANA Glazing Manual and FGMA Sealant Manual for glazing installation methods.

1.07 PRE-INSTALLATION MEETING

A. Convene a minimum of one week before starting work of this section.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not install glazing when ambient temperature is less than 50 degrees F.

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 WARRANTY

A. See Section 017700 - Closeout Procedures, for additional warranty requirements.

B. Provide a five (5) year warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same.

PART 2 - PRODUCTS

2.01 GLASS MATERIALS

A. Float Glass: 1/4 inch float glass.

B. Tempered Glass: 1/4 inch thick, tempered, in locations as required by 2003 International Building Code, conforming to ANSI Z97.1, ASTM C 1036, ASTM C 1048, and Consumer Product Safety Commission 16 CFR 1201.

C. Clear Float Glass: Float type, heat strengthened, clear conforming to ASTM E774 and ASTM E773.

D. Low E Glass: Solarban 60 (2) + Clear Insulating glass, Float type, tempered, clear conforming to ASTM E774 and ASTM E773.

1. Coating installed on third surface.

2. All exterior glazing unless otherwise noted.

E. Laminated glass to comply with ASTM C1172.

F. Coated Spandrel Float Glass: Float glass complying with requirements as follows:
1. Outdoor lite to match adjacent glazing.
2. Fallout Resistance: Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.
3. Factory apply manufacturer's standard opacifier of the following material to coated second surface of lites, with resulting products complying with GTA 89-1-6.

a. Manufacturer's standard opacifier material.

4. Color of spandrel glazing to be selected on site to provide for an equal match in color to adjacent glazing

G. Fire Lite PLUS:

1. Fire rated up to 90 minutes, 5/16 rated thick, 4lbs per square foot., visible light transmission -85%, visible reflection. 9% impact safety rating- meet ANSI Z 97.1 and CPSC 16 CFR 1201 (CAT I and II).

a. Contractor shall coordinate with Code floor plan for locations of glazing within rated doors and windows that are located in rated walls.

H. All Glass shall be heat strengthened or tempered as required by codes, or as required to meet thermal stress and wind loads.

2.02 SEALED INSULATING GLASS MATERIALS

A. Glass Units – All Facades:

1. All exterior glazing shall be 1-inch insulated units of 5/16-inch Clear, heat strengthened glass with a 7/16-inch air space and an inboard lite of 1/4-inch tempered PPG Solarban 60 (2) + Clear Insulating glass

2. All exterior glazing units shall have a solar heat gain coefficient of .27 or better.

B. Fire Lite PLUS:

1. Fire rated up to 90 minutes, 5/16 rated thick, 4lbs per square foot., visible light transmission -85%, visible reflection. 9% impact safety rating- meet ANSI Z 97.1 and CPSC 16 CFR 1201 (CAT I and II).

2.03 MIRRORED GLASS

A. Silvered Mirrored Glass: Clear float glass with successive layers of chemically deposited silver, electrically or chemically deposited copper, and manufacturer's standard organic protective coating applied to second glass surface to produce a coating system complying with FS DD-M-411. ¼" Thickness.

B. Mirrored Glass Edge Treatment: Treat edges as indicated below.
1. Flat polished edge at all locations unless indicated otherwise.
2. ½" Beveled polished edge, where indicated.
3. Seal edges of silvered mirrored glass after edge treatment to prevent chemical or atmospheric penetration of glass coating.

2.04 GLAZING COMPOUNDS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Manufacturers:

a. Vitro Architectural Glass

b. Dow Corning Corporation; 999-A.
c. GE Silicones - Silicones; SCS 1200.
d. Pecora Corporation; 860.
e. Tremco Incorporated; Proglaze.

2.05 GLAZING ACCESSORIES

A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness, ASTM C 864 Option I. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.

C. Glazing Tape: Preformed butyl compound with integral resilient tube spacing device; 10 to 15 Shore A durometer hardness; coiled on release paper, black color.

D. Glazing Clips: Manufacturer's standard type.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant.

D. Install sealants in accordance with ASTM C 1193 and FGMA Sealant Manual.

E. Install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION - EXTERIOR WET/DRY METHOD (PREFORMED TAPE AND SEALANT)

A. Cut glazing tape to length and set against permanent stops, 3/16 inch below sight line. Seal corners by butting tape and dabbing with butyl sealant.

B. Apply heel bead of butyl sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete the continuity of the air and vapor seal.

C. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.

D. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to attain full contact at perimeter of pane or glass unit.

E. Fill gap between glazing and stop with butyl type sealant to depth equal to bite of frame on glazing, but not more than 3/8 inch below sight line.

F. Apply cap bead of butyl type sealant along void between the stop and the glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.04 INSTALLATION - INTERIOR WET/DRY METHOD (TAPE AND SEALANT)

A. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.

B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.

C. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.

D. Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch intervals, 1/4 inch below sight line.

E. Fill gaps between pane and applied stop with butyl type sealant to depth equal to bite on glazing, to uniform and level line.

F. Trim protruding tape edge.

3.05 CLEANING

A. Remove glazing materials from finish surfaces.

B. Remove labels after Work is complete.

C. Clean glass and adjacent surfaces.

3.06 PROTECTION OF FINISHED WORK

A. After installation, mark pane with an 'X' by using removable plastic tape or paste. .

3.07 SCHEDULE

A. Interior Windows: Glazing as indicated in this section.

B. Hollow Steel Frames:

1. Interior non-rated: Tempered glass.

C. Steel Doors:

1. Exterior: Insulated glass
2. Interior non-rated: Tempered glass.

D. Wood Doors:

1. Interior non-rated: Tempered glass.
2. Interior rated: FireLite PLUS

E. Aluminum Storefront and Entrances

1. Exterior: As scheduled in 2.02, A., 1. of this Section.
2. Interior: Tempered glass

F. Aluminum Curtainwall:

1. Exterior: As scheduled in 2.02, A., 1. of this Section.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

B. Related Sections include the following:

1. Division 5 Section "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.
2. Division 7 Section "Building Insulation" for insulation installed with Z-shaped furring members.
3. Division 7 Section "Fire-Resistive Joint Systems" for head-of-wall joint systems installed with non-load-bearing steel framing.
4. Division 9 Section "Portland Cement Plaster" for metal lath supported by non-load-bearing steel framing.
5. Section 092900 – Gypsum board

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For dimpled steel studs and runners and firestop tracks, from ICC-ES.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M**,** G40 (Z120), hot-dip galvanized unless otherwise indicated.

B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.

1. Steel Studs and Runners:

a. Minimum Base-Metal Thickness: 25 GAGB.
b. Depth: 3-5/8 inches (92 mm), 6 inches (152 mm), 4 inches (102 mm), 2-1/2 inches (64 mm), and 1-5/8 inches (41 mm).

2. Dimpled Steel Studs and Runners:

a. Minimum Base-Metal Thickness: 25 GAGB.
b. Depth: 3-5/8 inches (92 mm), 6 inches (152 mm), 4 inches (102 mm), 2-1/2 inches (64 mm), and 1-5/8 inches (41 mm).

C. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements:

1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
2) MBA Building Supplies; FlatSteel Deflection Track or Slotted Deflecto Track.
3) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
4) Superior Metal Trim; Superior Flex Track System (SFT).
5) Telling Industries; Vertical Slip Track or Vertical Slip Track II.

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
b. Grace Construction Products; FlameSafe FlowTrak System.
c. Metal-Lite, Inc.; The System.
d. Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 20 GAGB 0.027 inch (0.68 mm).

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: 25 GAGB
2. Depth: 7/8 inch (22.2 mm).

G. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

H. Cold-Rolled Furring Channels: 18 GAGE uncoated-steel thickness, with minimum 1/2-inch-wide flanges.

1. Depth: 3/4 inch.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 20 GAGE.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 16 GAGE diameter wire, or double strand of 18 GAGE diameter wire.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 25 GAGE, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 16 GAGE diameter wire, or double strand of 18 GAGE diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

a. Type: Cast-in-place anchor, designed for attachment to concrete forms.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.

1. Depth: 2-1/2 inches.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.027 inch.
b. Depth: 1-5/8 inches.

3. Dimpled Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 25 GAGE.
b. Depth: 1-5/8 inches.

4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base-Metal Thickness: 25 GAGE.

5. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.

a. Configuration: Asymmetrical or hat shaped.

G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Armstrong World Industries, Inc.; Drywall Grid Systems.
b. Chicago Metallic Corporation; Drywall Grid System.
c. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where

offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.

2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install studs of the following gages:
1. Partitions less than 15 feet high: 25 gage.
2. Partitions 15 feet or more high: 20 gage.
3. Double jambs at door and other openings: 20 gage.
4. Partition corners: 20 gage.
5. End of freestanding partition: 20 gage.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:

    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Furring Members:

1. Erect insulation, specified in Division 07 Section "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring

channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches (1219 mm) o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

    a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems per details on drawings.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (non cumulative) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 09 2900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.
3. Tile backing panels.
4. Texture finishes.

B. Related Requirements:

1. Division 06 Section "Sheathing" for gypsum sheathing for exterior walls.
2. Division 09 Section "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
3. Division 09 Section "Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.
2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.
3. Mock-Up: See section 03-3100 Project Management and Coordination for Building Assemblies Mock-up requirements.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Low Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. Lafarge North America Inc.
5. National Gypsum Company.

6. PABCO Gypsum.
7. Temple-Inland.
8. USG Corporation.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

C. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10.

D. Impact-Resistant Gypsum Board (VHI): ASTM C 1629/C 1629M, Level 2.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
4. *At all coordiors.

2.4 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; GlasRoc Sheathing.
b. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
c. National Gypsum Company; Gold Bond, e(2)XP.
d. USG Corporation; Securock Glass Mat Sheathing.

2. Core: 5/8 inch, Type X.

2.5 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; GlasRoc Tile Backer.
b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.

2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D 3273, score of 10.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:

    a. Cornerbead.
    b. Bullnose bead.
    c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    d. L-Bead: L-shaped; exposed long flange receives joint compound.
    e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    f. Expansion (control) joint.
    g. Curved-Edge Cornerbead: With notched or flexible flanges.
    h. Expansion (control) joint.

B. Exterior Trim: ASTM C 1047.

1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
2. Shapes:

    a. Cornerbead.
    b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Fry Reglet Corp.
    b. Gordon, Inc.
    c. Pittcon Industries.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.

3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

D. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
2. Cementitious Backer Units: As recommended by backer unit manufacturer.
3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.8 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
b. Grabber Construction Products; Acoustical Sealant GSC.
c. Pecora Corporation; AC-20 FTR.
d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
e. USG Corporation; SHEETROCK Acoustical Sealant.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

G. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

2.9 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

B. Non-Aggregate Finish: Pre-mixed, vinyl texture finish for spray application.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; ProRoc Easi-Tex Spray Texture.
b. USG Corporation; BEADEX FasTex Wall and Ceiling Spray Texture.

2. Texture: Light spatter

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc., except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments (including but not limited to load bearing walls, columns, roof deck, etc.), except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with

manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Type 'X': In all areas – except as noted below.
   2. Flexible Type: Apply in double layer at curved assemblies.
   3. Impact-Resistant Type: As indicated on Drawings.
   4. Moisture- and Mold-Resistant Type: At all wet areas.

B. Single-Layer Application:

   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

   3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
   4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

   1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
   4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum

board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.4 APPLYING EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

3.5 APPLYING TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated and locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

B. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.

C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.6 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect. At minimum provide control joints in the following conditions:

1. At all construction joints (expansion, seismic or building control elements)
2. At a wall or partition runs an uninterrupted straight plane exceeding 30 linear feet.
3. At an interior ceiling with perimeter relief so that dimensions between control joints does not exceed 50 linear feet or the area of the ceiling between joints exceeds 2,500sf
4. At an interior ceiling without perimeter relief so that dimensions between control joints does not exceed 30 linear feet or the area of the ceiling between joints exceeds 900sf
5. At an exterior ceiling or soffit so that dimensions between control joints does not exceed 30 linear feet or the area of the ceiling or soffit between joints exceeds 900sf

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. Bullnose bead.
3. LC-Bead: J-shaped; exposed long flange receives joint compound.
4. L-Bead: L-shaped; exposed long flange receives joint compound.
5. U-Bead: J-shaped; exposed short flange does not receive joint compound.
6. Curved-Edge Cornerbead: With notched or flexible flanges.

D. Exterior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.

E. Aluminum Trim: Install in locations indicated on Drawings.

3.7 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints**,** rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile and that are substrate for acoustical tile.
3. Level 3: Storage rooms, mechanical, electrical and other service type rooms, at other locations noted on drawings.
4. Level 4: At all other locations

    a. Primer and its application to surfaces are specified in other Division 09 Sections.

5. Level 5: Where wall heights exceed 16’-0” or surface area exceeds 500sf uninterrupted by wall mounted equipment. This surfaces will be approved by the architect in writing prior to primer and paint applications.

    a. Primer and its application to surfaces are specified in other Division 09 Sections.

E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

H. Tolerances: Maximum Variation of Finished Gypsum Board Surface from True Flatness - 1/32 inch in 1 foot, 1/16 inch in 2 feet, 1/8 inch in 10 feet in any direction (non-cumulative).

3.8 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

3.9 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 2900

SECTION 093013 - TILING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Porcelain tile, thru-body.
   2. Solid surface thresholds installed as part of tile installations.
   3. Waterproof membrane for tile installations.
   4. Crack-suppression membrane for thin-set tile installations.

B. Related Sections include the following:
   1. Joint sealants: Section 07 92 00
   2. Tile backer units: Section 09 29 00.

1.2 DEFINITIONS

A. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.

B. Facial Dimension: Nominal tile size as defined in ANSI A137.1.

C. Wet Area: Tile surfaces that are either soaked, saturated, or regularly and frequently subjected to moisture or liquids (including water), such as gang showers, tub enclosures, showers, laundries, saunas, steam rooms, swimming pools, hot tubs, and exterior areas.

1.3 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
   1. Level Surfaces: Minimum 0.6.

1.4 SUBMITTALS

A. Product Data: For each type of tile, mortar, grout, and other products specified.

B. Samples for Verification: Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal color and texture variations, include Sample sets showing the full range of variations expected.
   1. Each type and composition of tile and for each color and texture required, at least 12 inches(300 mm) square, mounted on braced cementitious backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Architect.
   2. Full-size units of each type of trim and accessory for each color required.
   3. Solid surface thresholds in 6-inch (150-mm) lengths.

1.5 INFORMATIONAL SUBMITTALS

A. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

B. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of architects and owners, and other information specified.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Source Limitations for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.

C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

D. Source Limitations for Other Products: Obtain each of the products specified in this Section from one source and by a single manufacturer for each product.

E. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Meetings."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

C. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

1.9 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide products indicated in the ceramic tile installation schedules at the end of this Section.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Tile Products:
      a. American Olean Tile Company.
      b. Crossville Ceramics.
      c. Dal-Tile Corporation.
      d. Arizona Tile
   2. Tile-Setting and -Grouting Materials:
      a. American Olean Tile Company.
      b. Dal-Tile Corporation.
      c. Custom Building Products.
      d. Laticrete International, Inc.
      e. Mapei Corporation.

2.2 PRODUCTS, GENERAL

A. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.

B. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
   1. Provide tile color, texture and patterns indicated on Finish Schedule on the ID Drawings.
   2. Provide tile trim and accessories that match color and finish of adjoining flat tile.

C. Factory Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.

D. Mounting: Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.
   1. Where tile is indicated for installation in swimming pools, on exteriors, or in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for these kinds of installations and has a record of successful in-service performance.

E. Crack Supression Membrane for thin set applications: Acceptable Product; Laticrete Blue 92 Anti-Fracture Membrane.

2.3 TILE PRODUCTS

A. Refer to Drawings.

B. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:
   1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
   2. Shapes: As follows, selected from manufacturer's standard shapes:
      a. Base for Thin-Set Mortar Installations: Straight.
      b. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose.
      c. External Corners for Thin-Set Mortar Installations: Surface bullnose.
      d. Internal Corners: Field-butted square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

2.4 THRESHOLDS AND EDGE PROTECTION

A. Thresholds:
   1. Solid Surface Thresholds:
      a. Type: Solid surface type. DuPont, Corian or equivalent.
      b. Color and Finish: Refer to Finish Legend on Drawings.
      c. Size: 1-1/2 by 1/2 inch size by full width of wall or frame opening.
      d. Edges: Beveled one side when abutting other floor surfaces, radius edges from bevel to vertical face.
   2. General: Provide solid surface thresholds that are uniform in color and finish, fabricated to sizes and profiles indicated to provide transition between tile surfaces and adjoining finished floor surfaces.

B. Edge Protection: Roll-formed Type 304 stainless steel, height as required to accept scheduled tile thickness.
   1. Acceptable Products:
      a. Tile-to-Concrete: “RENO-U,” model AEU as manufactured by Schluter Systems, in height as required to accommodate scheduled tile and setting bed thickness.
      b. Tile-to Carpet: “RENO-TK,” model AETK as manufactured by Schluter Systems

2.5 WATERPROOFING FOR TILE INSTALLATIONS

A. General: Provide products that comply with ANSI A118.10 and the descriptions in this Article.

B. Polyethylene-Sheet Waterproofing: Manufacturer's standard proprietary product consisting of composite sheets, 60 inches (152 mm) wide by a nominal thickness of 0.030 inches (0.76 mm), composed of an inner layer of non-plasticized, chlorinated polyethylene sheet faced on both sides with laminated, high-strength, non-woven polyester material, designed for embedding in latex-portland cement mortar and as the substrate for latex-portland cement mortar setting bed.

C. Latex-Rubber Waterproofing: Manufacturer's standard factory-packaged, job-mixed, proprietary, 2-part formulation consisting of liquid-latex rubber and powder for trowel application and glass-fiber-fabric reinforcing.

D. Acrylic-Latex Waterproofing: Manufacturer's standard proprietary product consisting of one-part acrylic-latex additive and flexible cementitious fiber mortar, factory packaged for job-mixing and trowel application.

E. Urethane Waterproofing and Tile-Setting Adhesive: Manufacturer's standard proprietary product consisting of 1-part liquid-applied urethane in a consistency suitable for trowel

application and intended for use as both waterproofing and tile-setting adhesive in a 2-step process.

F. Products: Subject to compliance with requirements, provide one of the following:
   1. Polyethylene-Sheet Waterproofing:
      a. Nobleseal TS; Noble Company (The).
   2. Latex-Rubber Waterproofing:
      a. Trowel & Seal Waterproof Membrane; Custom Building Products.
      b. Laticrete 9235 Waterproof Membrane; Laticrete International, Inc.
      c. S-9000; Summitville Tiles, Inc.
   3. Acrylic-Latex Waterproofing:
      a. PRP 315; Mapei Corporation.
   4. Urethane Waterproofing and Tile-Setting Adhesive:
      a. Hydroment Ultra-Set; Bostik.
      b. Deck-Seal 1000; Southern Grouts & Mortars, Inc.

G. Waterproofing Membrane:
   1. Polyethylene-Sheet Product: Polyethylene faced on both sides with fleece webbing for adhering to latex-portland cement mortar; 39 inches (1000 mm) wide by 0.008-inch (0.203-mm) nominal thickness.
   2. Acceptable Product: Schluter Systems L.P.; KERDI

2.6 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4, composed as follows:
   1. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of prepackaged dry-mortar mix and liquid-latex additive complying with the following requirements:
      a. Latex Additive: Styrene butadiene rubber.
      b. For wall applications, provide non-sagging, latex-portland cement mortar complying with ANSI A118.4 for mortar of this type defined in Section F-2.1.2.

B. Chemical-Resistant, Water-Cleanable, Ceramic Tile-Setting and -Grouting Epoxy: ANSI A118.3 with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   1. Provide product capable of resisting continuous and intermittent exposure to temperatures of up to 140 deg F(60 deg C) and 212 deg F(100 deg C), respectively, as certified by mortar manufacturer for intended use.

C. Water-Cleanable, Tile-Setting Epoxy Adhesive: ANSI A118.3.

2.7 GROUTING MATERIALS

A. Chemical-Resistant Epoxy Grout: ANSI A118.3, color as indicated.
   1. Provide product capable of resisting continuous and intermittent exposure to temperatures of up to 140 deg F(60 deg C) and 212 deg F(100 deg C), respectively, as certified by mortar manufacturer for intended use.

B. Standard Unsanded Cement Grout: ANSI A118.6, color as indicated.

C. Grout Sealer:
   1. Water-based acrylic sealant, 15 percent resin solids, designed to effectively seal grout from common staining materials and prevent the absorption of liquids leaving a smoother finish with a clear film on top of the grout.

2. Does not turn white when exposed to standing water.
3. Not easily removed by common household cleaners.
4. Acceptable Product: CeramaSeal Grout Sealer by Bostik, Middleton, MA.

2.8 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section "Joint Sealants."
1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

C. Chemical-Resistant Sealants: For chemical-resistant floors, provide sealants compatible with chemical-resistant mortars and grouts, approved for use indicated by manufacturers of both mortar/grout and sealant and with chemical-resistance properties equivalent to mortar/grout.

D. Products: Subject to compliance with requirements, provide one of the following:
1. One-Part, Mildew-Resistant Silicone Sealants:
a. Dow Corning 786; Dow Corning Corporation.
b. Sanitary 1700; GE Silicones.
c. Pecora 898 Sanitary Silicone Sealant; Pecora Corp.
d. Rhodorsil 6B White; Rhone-Poulenc, Inc.
e. Tremsil 600 White; Tremco, Inc.

2.9 TILE BACKER UNITS

A. Refer to Section 09 29 00.

2.10 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland-cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Temporary Protective Coating: Provide product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; is compatible with tile, mortar, and grout products; and is easily removable after grouting is completed without damaging grout or tile.
1. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as a temporary protective coating for tile.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.11 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
   1. Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.
   2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
   3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust latter in consultation with Architect.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, verify that tile has been blended in the factory and packaged so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

B. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent adhesion or staining of exposed tile surfaces by grout, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating them with a continuous film of temporary protective coating indicated below, taking care not to coat unexposed tile surfaces:
   1. Grout release.

3.3 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 series of tile installation standards in "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.

B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.

C. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are the same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
   1. For tile mounted in sheets, make joints between tile sheets the same width as joints within tile sheets so joints between sheets are not apparent in finished work.

F. Lay out tile wainscots to next full tile beyond dimensions indicated.

G. Movement Joints: Locate movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. Locate joints in tile surfaces directly above joints in concrete substrates.
   2. Locate joints where tilework abuts restraining surfaces, such as perimeter walls, dissimilar floors, curbs, columns, pipes, ceilings, and where changes occur in backing materials.
   3. Prepare joints and apply sealants to comply with requirements of Division 07 Section "Joint Sealants."

H. Grout tile to comply with the requirements of the following tile installation standards:
   1. For chemical-resistant epoxy grouts, comply with ANSI A108.6.

I. At wet walls and elsewhere indicated on the Drawings, install tile backer units and treat joints to comply with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

J. Provide submittals as required by Section 01 8113 Supplemental Tables:
   1. Submittal Requirements for LEED v4 Environmental Quality Credits

3.4 WATERPROOFING INSTALLATION

A. Install waterproofing to comply with waterproofing manufacturer's written instructions to produce a waterproof membrane of uniform thickness bonded securely to substrate.

B. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.5 SHEET MEMBRANE INSTALLATION

A. Thoroughly clean existing surfaces scheduled to receive tile finish to ensure the removal of all grease, oil or dust film.

B. Apply a latex modified cementitious levelling coat wherever a slight substrate irregularity exists.

C. Crack Suppression Membrane: Install uncoupling membrane over structural concrete slab. Apply uncoupling membrane to substrate with recommended bonding mortar for substrate, applied using a notched trowel. Solidly embed scrim membrane into mortar.

D. Waterproofing Membrane: Install waterproofing to comply with waterproofing manufacturer's written instructions to produce a waterproof membrane of uniform thickness bonded securely to substrate.
   1. Fully adhere waterproof membrane to substrate with tile setting adhesive, with no air pockets.
   2. Tightly butt adjacent sheets and cover with a 125 mm (5 inch) strip of waterproofing membrane sealed to primary membranes.
   3. Provide manufacturer’s waterproofing strips where required to span expansion joints or terminate waterproofing into movement-joint type tile-setting accessories, as detailed per manufacturer’s instructions.
   4. Adhere waterproofing membrane to fixtures, joints around pipes, door and window frames, etc. with transparent waterproof sealant.

E. Cover tile-backer board joints with fibre mesh tape set in latex-Portland cement mortar

3.6 FLOOR TILE INSTALLATION

A. General: Install tile to comply with requirements in the Ceramic Tile Floor Installation Schedule, including those referencing TCA installation methods and ANSI A108 series of tile installation standards.

B. Joint Widths: Install tile on floors with the following joint widths:
   1. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).
   2. Paver Tile: 1/8 inch (3.2 mm).

C. Back Buttering: For installations indicated, obtain 100 percent mortar coverage by complying with applicable special requirements for back buttering of tile in referenced ANSI A108 series of tile installation standards:
   1. Exterior tile floors.
   2. Tile floors in wet areas, including showers, tub enclosures, laundries, and swimming pools.
   3. Tile floors installed with chemical-resistant mortars and grouts.
   4. Tile floors composed of tiles 8 by 8 inches (203 by 203 mm) or larger.
   5. Tile floors composed of rib-backed tiles.

D. Solid Surface Thresholds: Install solid surface thresholds at locations indicated; set in same type of setting bed as abutting field tile, unless otherwise indicated.
   1. Set thresholds in latex-portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent non-tile floor finish.

E. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

3.7 WALL TILE INSTALLATION

A. Install types of tile designated for wall installations to comply with requirements in the Ceramic Tile Wall Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.

B. Joint Widths: Install tile on walls with the following joint widths:
   1. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).

2. Glass Mosaic Tile: 1/16 inch (1.6 mm).
3. Wall Tile: 1/16 inch(1.6 mm).

C. Back Buttering: For installations indicated, obtain 100 percent mortar coverage by complying with applicable special requirements for back buttering of tile in referenced ANSI A108 series of tile installation standards:
1. Tile installed with chemical-resistant mortars and grouts.

3.8 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
1. Remove grout residue from tile as soon as possible.
2. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to brick and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.

C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure tile is without damage or deterioration at the time of Substantial Completion.
1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.9 FLOOR TILE INSTALLATION SCHEDULE

A. Ceramic Tile Floor Installation – (thin-set mortar bonded to concrete sub-floor, with epoxy grout): For interior floor installations of this designation, comply with the following:
1. Tile Type/Products: Refer to Finish Legend on Drawings.
2. Installation Method: TCA F115.
3. Setting Bed and Grout: ANSI A108.5 with the following mortar and grout:
   a. Chemical-resistant epoxy grout.
4. Seal grout.

B. Ceramic Tile Installation – (thick set mortar bed over slab-on-grade): For interior floor installations of this designation, comply with the following:
1. Tile Type/Products: Refer to Finish Legend on Drawings.
2. Installation Method: TCA F112.
3. Setting Bed and Grout: ANSI A108.1A with the following grout:
   a. ANSI A118.6 or ANSI A118.7.
4. Seal grout.

3.10 WALL TILE INSTALLATION SCHEDULE

A. Ceramic Tile Wall Installations - (thin-set bonded to gypsum Tile Backer on metal studs): For interior wall installations of this designation, comply with the following:
1. Tile Type/Products: Refer to Finish Legend on Drawings.

2. Installation Method: TCA W243.
3. Setting Bed and Grout: ANSI A118.3 with the following mortar and grout:
   a. Chemical-resistant epoxy.
   b. Chemical-resistant epoxy grout.
4. Seal grout.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

B. Related Requirements:
   1. None

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site**.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.

C. Samples for Initial Selection: For components with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

   1. Acoustical Panels: Set of **6-inch- (150-mm-) square;** Samples of each type, color, pattern, and texture.
   2. Exposed Suspension-System Members, Moldings, and Trim: Set of **6-inch- (150-mm-)** Samples of each type, finish, and color.
   3. Clips: Full-size **hold-down** and S**eismic** clips.

E. Delegated-Design Submittal: For seismic restraints for ceiling systems.

   1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.
    c. Grilles.
    d. Speakers.
    e. Sprinklers.
    f. Access panels.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: **1/8 inch = 1 foot.**

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical panel ceiling, for tests performed by **manufacturer and witnessed by a qualified testing agency**.

D. Evaluation Reports: For each acoustical panel ceiling suspension system **and anchor and fastener type**, from ICC-ES.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials**, from the same product run,** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size panels equal to **2** percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to **2** percent of quantity installed.

3. Hold-Down Clips: Equal to **2** percent of quantity installed.
4. Impact Clips: Equal to **2** percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer. Approved manufacturers:
1. Armsgtrong
2. USG
3. Rockfon

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class **A** according to ASTM E1264.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS

A. Basis of Design
1. Type A: Armstrong Optima Square Lay-In Panels
2. Type B: Armstrong Clean Room VL Unperforated Class 5 (where noted on drawings)

B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C. Classification: Provide Class A Fire Performance

D. Color: **White, NON- Fissured, NON- Textured**

E. Light Reflectance (LR): Not less than 0.88

F. Ceiling Attenuation Class (CAC): NA

G. Noise Reduction Coefficient (NRC): Not less than .90

H. Articulation Class (AC): Not less than **180**.

I. Edge/Joint Detail: **Square**.

J. Thickness: 3/**4 inch (19 mm)**.

K. Modular Size: **24 by 48 inches (610 by 1220 mm) and as indicated on Drawings**

L. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing

no mold, mildew, or bacterial growth when tested according to ASTM D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

2.4 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.

1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C635/C635M.

B. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation; with prefinished 9/16-inch- (15-mm-) wide metal caps on flanges.

1. Structural Classification: **Heavy**-duty system.
2. End Condition of Cross Runners: **Override (stepped)** type.
3. Face Design: **Flat, flush**.
4. Cap Material: Aluminum.
5. Cap Finish: **Painted white**

2.5 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to **five** times that imposed by ceiling construction, as determined by testing according to ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: **Post installed expansion** anchors.
b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B633, Class SC 1 (mild) service condition.
c. Corrosion Protection: Stainless-steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.
d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to **10** times that imposed by ceiling construction, as determined by

testing according to ASTM E1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
2. Stainless-Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than **0.106-inch- (2.69-mm-)** diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

F. Hold-Down Clips: Manufacturer's standard hold-down.

G. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

I. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

K. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including [**manufacturer's standard**] [**closed-cell PVC**] [**neoprene**] [**antimicrobial**] gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.

2. For lay-in panels with reveal edge details, provide s**tepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member**.
3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C636/C636M[**, seismic design requirements,** and manufacturer's written instructions.

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required **and, if permitted with fire-resistance-rated ceilings,** to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned acoustical panels as follows:

    a. As indicated on reflected ceiling plans.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install **seismic** clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.

7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
8. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of **1/8 inch in 12 feet (3 mm in 3.6 m)** non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of **1/8 inch in 12 feet (3 mm in 3.6 m)** non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: **Engage** a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

B. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf

(890 N) of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.

2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 09 65 13 – 13 RESILIENT WALL BASE

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 General Requirements, Specification Sections, apply to this section.

1.2 SUMMARY

A. Section includes:

i. Resilient Wall Base

1.3 SUBMITTALS, RELATED DOCUMENTS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures.

B. Product Data: Submit manufacturers documentation for each material and accessory proposed for use

i. Technical data sheet

ii. Care & maintenance document

iii. Warranty

C. LEED Submittals:

i. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content and chemical components.

D. Samples for Initial Selection: For each type of product indicated.

E. Samples for Verification: For each type of product indicated, in manufacturer's standard- size samples of each resilient product color, texture and pattern required.

F. Product Schedule: For resilient products. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide resilient wall base materials manufactured in the United States of America by a firm with a minimum of 10 years' experience with resilient vinyl materials of type equivalent to those specified.

B. Provide resilient wall base, flooring materials, adhesives, accessories and subfloor preparation products from one manufacturer to ensure color matching and compatibility.

C. Manufacturer shall be capable of providing technical training and technical field service representation.

1.5 RELATED WORK

A. Installer must be professional, licensed, insured and acceptable to manufacturer of resilient flooring materials. Project Managers or Field Supervisors must be INSTALL (International Standards & Training Alliance) certified CFI (Certified Floorcovering Installers) Certified and/or an FCICA (The Flooring Contractors Association) CIM (Certified Installation Manager) for the requirements of the project or equivalent.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within the range recommended 65 degrees F (18degrees C) and 85 degrees F (29 degrees C).

1.7 PROJECT CONDITIONS

A. Install resilient product s after other finishing operations, including painting, have been completed.

B. Maintain ambient temperatures within range of (± 10 degrees F) 65 degrees (18 degrees C) and 85 degrees F (29 degrees C) in the spaces to receive the resilient products during:

i. 48 hours before installation.

ii. During installation.

iii. 48 hours after installation.

C. Maintain relative humidity between 40% and 65% during installation.

D. Avoid conditions in which dew point causes condensation on the installation surface.

1.8 WARRANTY

A. Provide manufacturer's standard limited commercial warranty to cover manufacturing defects

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. **BASIS OF DESIGN:** Johnsonite Tarkette, www.commercial.tarkett.com

i. MILLWORK, REVEAL 6"

B. Roppe Corporation, www.roppe.com

C. Substitutions: See instructions for substitution requests.

2.2 PRODUCTS

A. WALL BASE specify - specify vinyl wall base with the following characteristics: Meets the performance requirements for the following Industry Standards:

i. ASTM F1861, Standard Specification for Resilient Wall Base, Type TV (vinyl, thermoplastic), Group 2 (solid, layered), Style A&B (Straight, Cove)

ii. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, Class A

iii. ASTM E648 (NFPA 253), Standard Test Method for Critical Radiant Flux, Class 1, >0.45 W/cm²

iv. ASTM E662 (NFPA 258), Standard Test Method for Smoke Density, Passes, <450

v. ASTM F137, Standard Test Method for Flexibility of Resilient Flooring Materials protocols, Passes

vi. ASTM F386, Standard Test Method for Thickness of Resilient Flooring Materials Having Flat Surfaces, Passes

vii. ASTM F925, Standard Test Method for Resistance to Chemicals of Resilient Flooring, Excellent

viii. ASTM F1515, Standard Test Method for Measuring Light Stability of Resilient Flooring protocols, Passes

ix. NFPA 253, Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Energy Source

x. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials

xi. NFPA 258, Test Method for Specific Density of Smoke Generated by Solid Materials

xii. Specify size by name and description: Roppe 2 1/2″ Vinyl Cove Base, Roppe 2 1/2″ Vinyl No Toe Base, Roppe 4″ Vinyl Cove Base, Roppe 4″ Vinyl No Toe Base, Roppe 6″ Vinyl Cove Base, Roppe 6″ Vinyl No Toe Base

xiii. Specify style by Alpha and name: A. Straight or B. Cove

xiv. Specify Color by Number and Name: To be selected by Owner during submittal process from manufacturers full range of standard colors.

2.3 INSTALLATION AND MAINTENANCE MATERIALS

A. Substrate/Background Preparation Products:

i. Adhesives: Adhesives should be selected based on the site conditions and use of the space being installed

B. Recommended Adhesive Products:

i. Excelsior WB-600 Acrylic Wall Base Adhesive by Roppe

a. Unit Size: 30 oz. cartridge, 1 Gallon & 4 Gallon

b. Coverage: 30 – 70 linear feet per cartridge, 180 – 340 linear feet per gallon

c. Standard installations over porous backgrounds

d. 100 % solids, solvent free and low VOCs

e. Hard set adhesive adding to dimensionally stable materials

f. Excellent sheer strength

ii. Excelsior C-630 Contact Adhesive provided by Roppe

a. Unit Size: 1 Quart

b. Coverage: 20 – 40 Square Feet per unit / 120 – 140 Linear Feet per unit

c. Standard installations over porous and non-porous substrates

d. Hard set adhesive adding to dimensionally stable materials

e. Excellent sheer strength

f. Superior bond strength

g. Great for environments with topical moisture

C. **Accessories:** Items needed to complete the installation. Recommended accessory products:

i. Inside corners

ii. Outside corners

iii. Color-matched caulks

D. **Maintenance Materials:** Proper maintenance of the installation is critical to the long term performance of the flooring products being specified. Using the appropriate chemicals to maintain the product according to the environment in which it is specified is critical. Recommend maintenance products:

i. Excelsior NC-900, All-Purpose Neutral pH Cleaner provided by Roppe

a. For initial maintenance

b. For daily and routine maintenance

ii. Excelsior FR-920 Finish Remover

a. For removing of topically applied finishes.

b. Highly concentrated, cuts through multiple layers of floor finish.

PART 3 – EXECUTION

3.1 GENERAL

A. General Contractor Responsibilities:

i. Supply a safe, climate controlled building as detailed in Roppe Technical Data Sheets.

ii. Ensure substrate/background meets the requirements of ASTM F1861, Roppe Technical Data Sheets and Excelsior Technical Data Sheets.

iii. Provide a secure storage area that is maintained permanently or temporarily at normal operating temperature and humidity conditions between 65° F and 85° F and between 40% and 65% relative humidity, for at least 48-hours prior to and during the application of the wall base, so the contractor can acclimate the vinyl base materials per manufacturer's instructions.

iv. Provide an installation area that is weather tight and maintained either permanently or temporarily at ambient service temperature and humidity. Normal operating temperature and humidity conditions are between 65° F and 85° F and between 40% and 65% relative humidity, for at least 48-hours prior to and during the application of the wall base per the manufacturer's instructions.

v. Ensure areas with direct prolonged exposure to sunlight are protected with protective UVA/UVB restrictive coatings or films.

vi. In areas where the walls are subject to direct sunlight through doors or windows, the doors and windows should be covered using blinds, curtains, cardboard or similar for the time of the installation and 72-hours after the installation to allow the adhesive to cure. Note: These areas should be installed using wet adhesives only.

vii. Conduct initial maintenance prior to final usage per the Roppe Care & Maintenance Documents. Do not conduct initial maintenance until adhesive has cured per the adhesive technical data.

viii. Provide trained installers that are professional, licensed, insured and acceptable to manufacturer of resilient vinyl wall base materials.

ix. Ensure installers or installation teams meet one of the following requirements:

a. Have completed INSTALL (International Standards & Training Alliance)

b. CFI (Certified Floorcovering Installers) training programs

c. Certified by INSTALL or CFI.

d. Are being supervised by Project Managers or Field Supervisors that are INSTALL (International Standards & Training Alliance) certified, CFI (Certified Floorcovering Installers) Certified and/or an FCICA (The Flooring Contractors Association) CIM (Certified Installation Manager).

x. Follow all requirements in the appropriate Roppe and/or Excelsior Technical Data Sheets, Care & Maintenance Documents, Warranties and other technical documents or instructions.

3.2 EXAMINATION

A. General: Follow guidelines laid out in Division 01, Section 01 71 00 – Examination and Preparation, as well as Section 01 43 00 – Quality Assurance.

B. Verification of Conditions: Inspect all substrates/backgrounds to ensure they are clean, smooth, permanently dry, structurally sound and without voids. Confirm all areas are properly sealed and acclimated per manufacturer's requirements.

C. Verification of Products: In accordance with manufacturer's installation requirements, visually inspect material for size, style, color or visual defects prior to installing. Any material that is incorrect or visually defective shall not be installed.

3.3 SUBSTRATE/BACKGROUND PREPARATION

A. General: Follow guidelines laid out in Division 01, Section 01 71 00 – Examination and preparation. All work required ensuring substrate/background meets manufacturers' guidelines are the responsibility of the general contractor.

B. Preparation: Ensure substrate/background meets the requirements of ASTM F1861 for resilient wall base and/or Roppe Technical Data Sheets and Excelsior Technical Data Sheets.

i. Substrates/backgrounds must be free of visible water or moisture, dust, sealers, paint, residual adhesives and adhesive removers, solvents, wax, oil, grease, mold, mildew and any other extraneous coating, film, material or foreign matter.

ii. Acclimate all products to be used during the installation and the installation environment prior to installation according to the manufacturers written instructions.

iii. Fill cracks, holes, depressions and irregularities in the substrate/background to prevent transferring through to the surface of the resilient wall base.

3.4 INSTALLATION

A. General: Follow all relevant guidelines detailed in Division 01, as well as wall base and adhesive manufacturer's technical data sheets.

B. Resilient Vinyl Wall Base: Install material in accordance with manufacturer's recommendations.

i. Select the appropriate adhesive for the application and job site conditions.

ii. Install material according to roll sequence or with like run numbers.

iii. Ensure material is rolled appropriately into the adhesive using a hand roller.

3.5 CLEANING & MAINTENANCE

A. General: Clean up installation area and vacuum dust or wipe material to remove any dirt, dust or debris.

B. Initial Maintenance: Conduct initial maintenance per the manufacturer's recommended procedures stated in the Maintenance Documents. All documentation is available upon request or from the Roppe website. Excelsior Cleaning products are the recommended products for use. All can be found linked to the product on the Roppe website or at www.excelsiorproducts.net.

C. Regular Maintenance: Conduct maintenance on regular intervals as needed. Insufficient cleaning will reduce the wear life of the wall base and alter the aesthetic properties of the wall base. The amount of maintenance depends directly upon the amount of dirt and particulates the area is subjected to.

3.6 CLOSEOUT ACTIVITIES

A. General: Follow all federal, state and local requirements and Division 01 Section 01 76 00 – Protecting Installed Construction and Section 01 78 00 – Closeout Submittal requirements for these activities, protecting installed construction.

B. Protection: Protect newly installed material from damage by other trades. Be sure all construction debris is picked up and vacuumed or removed prior to leaving the area. Limit usage and foot traffic according to the adhesive's requirements. When moving appliances or heavy furniture, protect wall base from scuffing and tearing using temporary floor protection as well.

END OF SECTION 09 65 13 13

SECTION 09 65 19.23 - RESILIENT VINYL TILE FLOORING

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

i. Solid Luxury Vinyl Plank and Tile Flooring

ii. Substrate Preparation

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

i. Section 03 30 00 CAST-IN-PLACE CONCRETE for concrete substrate; slab surface tolerances

ii. Section 06 10 00 ROUGH CARPENTRY for plywood substrate and surface tolerances

iii. Section 09 69 00 ACCESS FLOORING for resilient floor covering for access panels

C. References (Industry Standards):

i. ASTM International (ASTM):

a. ASTM F1700, Standard Specification for Solid Vinyl Tile

b. ASTM E648, Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

c. ASTM E662, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials

d. CAN/ULC-S102.2, Surface Burning

e. ASTM D2047, Standard Test Method for Static Coefficient of Friction as Measured by the James Machine

f. ASTM F970, Standard Test Method for Static Load Limit

g. ASTM F970 (Modified) - Modified Test Method for Static Load Limit

h. ASTM F925, Standard Test Method for Resistance to Chemicals of Resilient Flooring

i. ASTM F1515, Standard Test Method for Measuring Light Stability of Resilient Flooring by Color Change

j. ASTM F1914, Standard Test Method for Short-Term Indentation and Residual Indentation or Resilient Floor Covering

k. ASTM F2199, Dimensional Stability

ii. National Fire Protection Association (NFPA):

a. NFPA 253, Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Energy Source

b. NFPA 258, Test Method for Specific Density of Smoke Generated by Solid Materials

1.3 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures.

B. Product Data: Submit manufacturer's technical data sheet, care & maintenance document, submittal and/or warranty for each material and accessory proposed for use.

C. Samples: Submit representative samples of each product specified for verification, in manufacturer's standard size samples of each resilient product color, texture and pattern required.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide resilient flooring materials manufactured in the United States of America by a firm with a minimum of 10 years' experience with resilient flooring materials of type equivalent to those specified.

i. Provide resilient flooring products, including wall base, accessories and subfloor preparation products from one manufacturer to ensure color matching and compatibility.

ii. Manufacturer shall be capable of providing technical training and technical field service representation.

B. Installer Qualifications: Installer must be professional, licensed, insured and acceptable to manufacturer of resilient flooring materials. Project Managers or Field Supervisors must be INSTALL (International Standards & Training Alliance) certified CFI (Certified Floorcovering Installers) Certified and/or an FCICA (The Flooring Contractors Association) CIM (Certified Installation Manager) for the requirements of the project.

C. Sustainable Design Requirements:

i. Vinyl Plank and Tile flooring that does not require coatings and strippers or the use of chemicals that may be hazardous to human health to maintain.

ii. Vinyl Plank and Tile flooring compliant with CA Section 01350 (low-emitting (VOC) building products).

iii. Vinyl Plank and Tile flooring is free of materials known to be teratogenic, mutagenic or carcinogenic including halogens, asbestos and chlorines.

iv. Vinyl Plank and Tile flooring is 100% Recyclable.

v. Vinyl Plank and Tile flooring is SCS FloorScore® Certified.

vi. Vinyl Plank and Tile flooring contains EnviroSD, A Safe and Effective Antibacterial Agent.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.

B. Deliver materials sufficiently in advance of installation to condition materials to the required temperature for 48-hours prior to installation.

1.6 PROJECT CONDITIONS

A. Install Radius Luxury Vinyl Plank and Tile after other finishing operations, including painting, have been completed.

B. Maintain temperature at service levels and/or a steady ambient temperature between 65 degrees F and 85 degrees F (± 10° F) for at least 48-hours prior to, during and until substantial completion of installation.

C. Maintain relative humidity at service levels, or between 40% and 65% RH.

1.7 WARRANTY

A. Provide manufacturer's standard limited residential and commercial warranty to cover manufacturing defects:

i. 10 – Year Commercial Warranty

ii. 20 – Year Residential Warranty

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design: Patcraft, www.patcraft.com

2.2 RESILIENT LVT AND LVP VINYL FLOORING

A. VINYL TILES OR PLANKS - specify products with the following characteristics and meet the performance requirements for the following Industry Standards:

i. ASTM F1700, Specification for Solid Vinyl Tile, Class III, Type A & B - Printed Film Vinyl Tile, Type B Embossed Surface.

ii. ASTM E648 / NFPA 253, Flammability/Critical Radiant Flux; Class 1, > 0.45 W/cm²

iii. ASTM E662 / NFPA 258, Smoke Density; Passes < 450

iv. CAN / ULC – S102.2, Surface Burning: 30 FSR, 250 SDR

v. ASTM D2047, Slip Resistance; Passes > 0.6

vi. ASTM F970, Static Load Limit; Passes 250 PSI, Modified, Maximum Weight 2000 PSI

vii. ASTM F925, Chemical Resistance; Excellent (list of chemicals available)

viii. ASTM F1515, Light Stability; Passes < ΔE 8

ix. ASTM F1514, Heat Stability; Passes < ΔE 8

x. ASTM F1914, Short Term and Residual Indentation; Passes < 8%

xi. ASTM F2199, Dimensional Stability; Passes, 0.020” Lin/ft. maximum

2.3 INSTALLATION AND MAINTENANCE MATERIALS

A. Moisture Mitigation: Moisture testing is required for LVP and LVT installations. Mitigation should be performed if results indicate high levels of moisture. Recommended Moisture Mitigation Product:

i. Excelsior MM-100, Moisture Mitigation

a. Unit Size: 2.5 Gallons

b. Coverage: 1000 square feet per unit with one coat

c. MM-100 is a water, solvent and VOC free, polyurethane-based moisture mitigation product used to treat concrete slabs with excessive moisture levels beyond what flooring adhesives allow.

d. MM-100 can block moisture up to 20 lbs. MVER or 99% RH.

e. MM-100 is a single component product, eliminating extensive mix times and concerns regarding pot life.

f. MM-100 does not require aggressive concrete preparation, such as shotblasting or diamond grinding.

g. MM-100 is a two coat system that is incredibly easy to apply and does not require any specialized equipment, its excellent coverage rates also make it incredibly cost effective.

h. Despite being a two coat system, MM-100 is incredibly fast drying.

i. Flooring or subsequent coatings can be installed in less than two hours.

j. Backed by a 10 year material and labor warranty, MM-100 is a fast and easy solution for the moisture issues that commonly plague flooring installations.

B. Substrate Preparation Products: Substrates should be prepared to properly receive the resilient flooring products being specified. Trowelable leveling and patching compounds that are latex-modified, Portland cement based or blended hydraulic cement based formulation. Recommended Substrate Preparation Products:

i. Excelsior NP-230, Non-Porous Substrate Primer

a. Unit Size: 2.5 Gallons

b. Coverage: 1000 Square Feet per unit with one coat

c. Used over MM-100 to promote adhesion of cementitious materials

d. Single component and fast drying to allow for quick and easy installation

e. Contains an aggregate to provide mechanical bond for cementitious materials

ii. Excelsior CP-300, Cementitious Patch

a. Unit Size: 10 lb. Pail

b. Coverage: 33 Square Feet per unit @ 1/8”

c. Doesn’t require primer over porous substrates

d. Install flooring in as little as 30 minutes

iii. Excelsior SU-310, Self-Leveling Underlayment

a. Unit Size: 50 lb. Bag

b. 5500 PSI Compressive Strength after 28 days

c. Install flooring within 12 hours

d. Pumpable

C. Adhesives: Adhesives should be selected based on the site conditions and use of the space being installed. Recommended Adhesive Products:

i. Excelsior SP-500, Acrylic Aerosol Pressure Sensitive Spray Adhesive

a. Unit Size: 22 Ounces

b. Coverage: 100 Square Feet per 22 Ounce Can

c. Should only be used if Heat Welding finished seams

d. Standard installations over porous and non-porous substrates

e. Excellent sheer strength

f. Approved for Hill-Rom Beds

g. Approved for Immediate Use

h. Installation Limits

(1) 90% RH, ASTM F2170

(2) 8 lbs. MVER, ASTM F1869

ii. Excelsior AP-520, Acrylic Roll-On Pressure Sensitive Adhesive

a. Unit Size: 2.5 Gallons

b. Coverage: 1000 Square Feet per Unit

c. Should only be used if Heat Welding finished seams

d. Standard installations over porous and non-porous substrates
e. Excellent sheer strength
f. Approved for Hill-Rom Beds
g. Approved for Immediate Use
h. Installation Limits
(1) 80% RH, ASTM F2170
(2) 8 lbs. MVER, ASTM F1869

iii. Excelsior AW-510, Acrylic Wet-Set Adhesive
a. Unit Size: 1 Gallon & 4 Gallon
b. Coverage: 150 Square Feet
c. Standard installations over porous and non-porous substrates
d. Hard set adhesive adding to dimensionally stable materials
e. Excellent sheer strength
f. Approved for Hill-Rom Beds
g. Installation Limits
(1) 90% RH, ASTM F2170
(2) 6 lbs. MVER, ASTM F1869

iv. Excelsior MS-700, Modified Silane Wet-Set Adhesive
a. Unit Size: 3 Gallon
b. Coverage: 480-705 Square Feet per unit
c. Standard installations over porous and non-porous substrates
d. Excellent green grab
e. Hard set adhesive adding to dimensionally stable materials
f. Excellent sheer strength
g. Approved for Hill-Rom Beds
h. Superior bond strength
i. Great for environments with topical moisture
j. Great for exterior applications
k. Installation Limits, Indoor Installations only
(1) 95% RH, ASTM F2170
(2) 10 lbs. MVER, ASTM F1869

v. Excelsior EW-710, Epoxy Wet-Set Adhesive
a. Unit Size: 1 Gallon
b. Coverage: 150 Square Feet per unit
c. Standard installations over porous and non-porous substrates
d. Excellent green grab
e. Hard set adhesive adding to dimensionally stable materials
f. Excellent sheer strength
g. Approved for Hill-Rom Beds

h. Superior bond strength
i. Great for environments with topical moisture
j. Great for exterior applications
k. Installation Limits, Indoor Installations only
(1) 90% RH, ASTM F2170
(2) 6 lbs. MVER, ASTM F1869

D. Maintenance Materials: Proper maintenance of the installation is critical to the long term performance of the flooring products being specified. Using the appropriate chemicals to maintain the product according to the environment in which it is specified is critical. Recommend maintenance products:
i. Excelsior NC-900, All-Purpose Neutral pH Cleaner
a. For initial maintenance
b. For daily and routine maintenance
ii. Excelsior MF-940, Acrylic Matte Floor Finish
iii. Excelsior GF-950, Acrylic Gloss Floor Finish
iv. Excelsior FR-920, Finish Remover

PART 3 – EXECUTION

3.1 GENERAL

A. General Contractor Responsibilities:
i. Supply a safe, climate controlled building and subfloor.
ii. Ensure substrate meets the requirements of ASTM F710.
iii. Provide a secure storage area that is maintained permanently or temporarily at normal operating temperature and humidity conditions between 65° F and 85° F and between 40% and 65% relative humidity, for at least 48-hours prior to and during the application of the flooring, so the flooring contractor can acclimate the flooring materials per manufacturer's instructions.
iv. Provide an installation area that is weather tight and maintained either permanently or temporarily at ambient service temperature and humidity. Normal operating temperature and humidity conditions are between 65° F and 85° F and between 40% and 65% relative humidity, for at least 48-hours prior to and during the application of the flooring per the manufacturer's instructions.
v. Ensure areas with direct prolonged exposure to sunlight are protected with protective UVA/UVB restrictive coatings or films.
vi. Areas of the flooring that are subject to direct sunlight through doors or windows should have them covered using blinds, curtains, cardboard or similar for the time of the installation and 72-hours after the installation to allow the adhesive to cure. Note: These areas should be installed using wet adhesives only.
vii. Conduct initial maintenance prior to final usage. Do not conduct initial maintenance until adhesive has cured per the adhesive technical data.

B. Flooring Contractor Responsibilities:

i. Provide trained installers that are professional, licensed, insured and acceptable to manufacturer of resilient flooring materials.

ii. Ensure installers or installation teams meet one of the following requirements:

iii. Have completed INSTALL (International Standards & Training Alliance) or CFI (Certified Floorcovering Installers) training programs and/or are certified by INSTALL or CFI.

iv. Are being supervised by Project Managers or Field Supervisors that are INSTALL (International Standards & Training Alliance) certified, CFI (Certified Floorcovering Installers) Certified and/or an FCICA (The Flooring Contractors Association) CIM (Certified Installation Manager).

v. Follow all requirements in the appropriate Six Degrees and/or Excelsior Technical Data Sheets, Care & Maintenance Documents, Warranties and other technical documents or instructions.

3.2 EXAMINATION

A. General: Follow guidelines laid out in Division 01, Section 01 71 00 – Examination and Preparation, as well as Section 01 43 00 – Quality Assurance.

B. Verification of Conditions**:** Inspect all substrates to ensure they are clean, smooth, permanently dry, flat, and structurally sound. Confirm all areas are properly sealed and acclimated per manufacturer's requirements.

C. Verification of Products: In accordance with manufacturer's installation requirements, visually inspect material for size, color or visual defects prior to installing. Any material that is incorrect or visually defective shall not be installed.

3.3 SUBSTRATE PREPARATION

A. General: Follow guidelines laid out in Division 01, Section 01 71 00 – Examination and preparation. All work required ensuring substrate or subfloor meets manufacturers' guidelines are the responsibility of the general contractor.

B. Preparation: Ensure substrate meets the requirements of ASTM F710 for concrete substrates and ASTM F1482 for wood substrates and/or Six Degrees Technical Data Sheets and Excelsior Technical Data Sheets.

i. Substrates must be free of visible water or moisture, dust, sealers, paint, sweeping compounds, curing compounds, residual adhesives and adhesive removers, concrete hardeners or densifiers, solvents, wax, oil, grease, asphalt, visible alkaline salts or excessive efflorescence, mold, mildew and any other extraneous coating, film, material or foreign matter.

ii. It is recommended that all substrates have a floor flatness of FF32 and/or flatness tolerance of 1/8" in 6' or 3/16" in 10'.

iii. Acclimate all products to be used during the installation in the installation environment prior to installation according to the manufacturers written instructions.

C. Concrete Substrates:

i. Moisture Testing: Perform moisture testing per the manufacturer's recommendations to determine conditions, it is recommended to treat new and existing slabs a little bit different to ensure adequate conditions exist for installation.

a. New Slabs on all grade levels: it is recommended to perform ASTM F2170 Relative Humidity testing no more than a week prior to installation to determine the levels present and when to proceed with the installation.

b. Existing Slabs on all grade levels: in addition to ASTM F2170 testing, existing slabs that have previously had floor covering installed, must be tested to ASTM F1869 Calcium Chloride test kits to determine the MVER of the concrete.

ii. Mechanically remove contamination on the substrate that may cause damage to the flooring material, this includes paint, permanent and non-permanent markers, pens, crayons, etc. Leaving these on the substrate or marking with them on the back of the material could cause bleed through and damage the flooring.

iii. Fill cracks, holes, depressions and irregularities in the substrate to prevent transferring through to the surface of the resilient flooring. Use a high-quality Portland cement based product such as Excelsior installation products provided by Six Degrees.

iv. Do not install material over expansion joints.

D. Wood Substrates: Wood substrates must have a minimum 18” (45.7 cm) of cross ventilated space beneath the joist.

i. Wood substrates must be a minimum 1” thick with a double layer construction.

ii. Wood substrates must be rigid and free of movement.

iii. Wood substrates must not be OSB (Oriented Strand Board), particle board, chipboard, luan or composite type underlayments.

iv. Wood substrates that are Single Wood or Tongue & Groove subfloors must be covered with the appropriate APA approved underlayment plywood:

a. Boards with a face width of 3” (7.62 cm) or less and is tongue-and-groove and with a smooth surface, use minimum 1/4” (6.4 mm) underlayment panels.

b. Boards with a face width greater than 3” (7.62 cm) or not tongue-and-groove, or with a rough surface, use minimum 1/2” (12.7 mm) underlayment panels.

3.4 INSTALLATION

A. General: Follow all relevant guidelines detailed in Division 01, as well as flooring and adhesive manufacturer’s technical data sheets.

B. Resilient Luxury Vinyl Flooring**:** Install material in accordance with manufacturer’s recommendations.

i. Select the appropriate adhesive for the application and job site conditions.

ii. Install material according to directional arrows on the back of the material.

iii. Ensure material is rolled appropriately into the adhesive using a 100 lb. three section roller.

3.5 CLEANING & MAINTENANCE

A. General: Clean up installation area and vacuum, dust or wipe material to remove any dirt, dust or debris.

B. Initial Maintenance: Conduct initial maintenance per the manufacturer’s recommended procedures stated in the Maintenance Documents.

C. Regular Maintenance: Conduct maintenance on regular intervals as needed. Insufficient cleaning will reduce the wear life of the flooring and alter the aesthetic properties of the planks and tiles. The amount of maintenance depends directly upon the amount of dirt and particulates the floor is subjected to.

3.6 CLOSEOUT ACTIVITIES

A. General: Follow all federal, state and local requirements and Division 01 Section 01 76 00 – Protecting Installed Construction and Section 01 78 00 – Closeout Submittal requirements for these activities.

B. Protection: Protect newly installed material with construction grade paper or protective boards, such as Masonite or Ram Board, to protect material from damage by other trades. Be sure all construction debris is swept up and removed prior to the protective material being installed and does not get trapped underneath. Limit usage and foot traffic according to the adhesive's requirements. When moving appliances or heavy furniture, protect flooring material from scuffing and tearing using temporary floor protection as well.

END OF SECTION 09 65 19.23

SECTION 096723 – RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. High-performance resinous flooring systems.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Installer Certificates for Qualification: Signed by manufacturer stating that installers comply with specified requirements.
C. Material Certificates: For each resinous flooring component, from manufacturer.
D. Maintenance Data: For maintenance manuals.
E. Samples: Submit two 6” X 6” samples of each resinous flooring system applied to a rigid backing. Provide sample which is a true representation of proposed field applied finish. Provide sample color and texture for approval from Owner in writing or approved by General Contractor prior to installation.
F. Product Schedule: For resinous flooring.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
   1. Engage an installer who is approved in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
   2. Installer Letter of Qualification: Installer to provide letter stating that they have been in business for at least 5 years and listing 5 projects in the last 2 years of similar scope. For each project provide: project name, location, date of installation, contact information, size of project, and manufacturer of materials with system information.
B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
C. Pre-installation Conference: Conduct conference at Project site before work and mockups begin.
D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Do not cover up mockup area.
   1. Apply full-thickness mockups on 16 square foot floor area selected by Architect.
   2. Finish surfaces for verification of products, color, texture, and sheen.
   3. Simulate finished lighting conditions for Architect's review of mockups.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
   5. Mockup shall demonstrate desired slip resistance for review and approval by Owner’s representative in writing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:
1. The Sherwin Williams Company, Cleveland, OH. swflooring@sherwin.com, or approved equal.

Resuflor Deco Quartz BC23, 1/8" nominal thickness.
2. Primer: Resuprime 3579 at 250 sq. ft. per gallon.
3. 1st Receiver Coat: Resuflor 3561 at 140-145 sq. ft. per gallon
4. 1st Broadcast: GP5900F to excess at 0.4 lbs. per sq. ft.
5. 2nd Receiver Coat: Resuflor 3561 at 65-70 sq. ft. per gallon
6. 2nd Broadcast: GP5900F to excess at 0.4 lbs. per sq. ft.
7. Grout Coat: Resuflor 3746 at 100 sq. ft. per gallon.
8. Topcoat: Resuflor 3746 at 200 sq. ft. per gallon.

2.2 MATERIALS

A. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24)].
1. Resinous Flooring: 100 g/L.

2.3 HIGH-PERFORMANCE RESINOUS FLOORING

A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance, resin-based, monolithic floor surfacing designed to produce a seamless floor.
B. System Characteristics:
1. Color and Pattern: As indicated from manufacturers listed above.
2. Slip Resistance: Provide slip resistant finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspection: Prior to commencing Work, thoroughly examine all underlying and adjoining work, surfaces and conditions upon which Work is in any way dependent for perfect results. Report all conditions which affect Work. No "waiver of responsibility" for incomplete, inadequate or defective underlaying and adjoining work, surfaces and conditions will be considered, unless notice of such unsatisfactory conditions has been filed and agreed to in writing before Work begins. Commencement of Work constitutes acceptance of surfaces.
B. Surface Preparation: Remove all surface contamination, loose or weakly adherent particles, laitance, grease, oil, curing compounds, paint, dust and debris by blast track method or approved mechanical means (acid etch not allowed). If surface is questionable, try a test patch. Create a minimum surface profile for the system specified in accordance with the methods described in ICRI No. 03732 to achieve profile numbers as follows:

1.	Thin film, to 10 mils	CSP-1 to CSP-3
2.	Thin and medium films, 10 to 40 mils	CSP-3 to CSP-5
3.	**Self-leveling mortars, to 3/16"**	**CSP-4 to CSP-6**
4.	Mortars and laminates, to 1/4" or more	CSP-5 to CSP-10

C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
   1. Moisture Testing: Perform tests indicated below.

      a. Calcium Chloride Test: Perform anhydrous calcium chloride test per ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lbs. of water/1000 sq. ft. in 24 hours. Perform tests so that each test area does not exceed 1000 sq. ft. and perform 3 tests for the first 1000 sq. ft. and one additional test for every additional 1000 sq ft.
      b. In-Situ Probe Test: Perform relative-humidity test using in-situ probes per ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative-humidity-level measurement.

3.2 ENVIRONMENTAL CONDITIONS

A. All applicators and all other personnel in the area of the RF installation shall take all required and necessary safety precautions. All manufacturers' installation instructions shall be implicitly instructions shall be implicitly followed.
B. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
C. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
E. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
F. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

3.3 APPLICATIONS

A. Install resinous floor over properly prepared concrete surface in strict accordance with the manufacturer's directions.
   1. Install the primer and/or base coats over thoroughly cleaned and prepared concrete.
   2. Install topcoat over flooring after excess aggregate has been removed.
   3. Maintain a slab temperature of 60°F to 80°F for 24 hours minimum before applying floor topping, or as instructed by manufacturer.
B. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
C. Sealant: Saw cut resinous floor topping at expansion joints in concrete slab. Fill sawcuts with sealant prior to final seal coat application. Follow manufacturer's written recommendations.
D. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
E. Slip Resistant Finish: Provide grit for slip resistance.
F. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.4 COMPLETED WORK

A. Cleaning: Upon completion of the Work, clean up and remove from the premises surplus materials, tools, appliances, empty cans, cartons and rubbish resulting from the Work. Clean off all spattering and drippings, and all resulting stains.

B. Protection: Protect Work in accordance with manufacturer's directions from damage and wear during the remainder of the construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.
C. Contractor shall insure that coating is protected from any traffic until it is fully cured to the satisfaction of the coating manufacturer.

END OF SECTION 096723

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on exterior substrates.

1. Concrete.
2. Concrete masonry units (CMUs).
3. Steel and iron.
4. Galvanized metal.
5. Aluminum (not anodized or otherwise coated).
6. Portland cement plaster (stucco).

B. Related Requirements:

1. Section 051200 "Structural Steel Framing", Section 051213 "Architecturally Exposed Structural Steel Framing" for shop priming of metal substrates.
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
3. Section 055116 "Metal Floor Plate Stairs" for shop priming metal floor plate stairs.
4. Section 055119 "Metal Grating Stairs" for shop priming metal grating stairs.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product listed in the Exterior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Interior Paints and Coatings: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

D. Colors: As selected by Architect from manufacturer's full range or as indicated in a color schedule.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Fiber-Cement Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.
4. Wood: 15 percent.
5. Portland Cement Plaster: 12 percent.
6. Gypsum Board: 12 percent.

C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.

D. Exterior Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

F. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer**.**

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Latex System MPI EXT 3.1A:

    a. Prime Coat: Primer, alkali resistant, water based, MPI #3.

    b. Prime Coat: Latex, exterior, matching topcoat.
    c. Intermediate Coat: Latex, exterior, matching topcoat.

    d. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

    e. Topcoat: Latex, exterior, semi-gloss (MPI Gloss Level 5), MPI #11.

B. CMU Substrates:

1. Latex System MPI EXT 4.2A:

    a. Prime Coat: Block filler, latex, interior/exterior, MPI #4.

    b. Intermediate Coat: Latex, exterior, matching topcoat.

    c. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

    d. Topcoat: Latex, exterior, semi-gloss (MPI Gloss Level 5), MPI #11.

C. Steel and Iron Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.1B:

    a. Prime Coat: Primer, alkyd, anti-corrosive for metal, MPI #79.
    b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.

    c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

    d. Topcoat: Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.

D. Galvanized-Metal Substrates:

1. Latex System MPI EXT 5.3A

    a. Prime Coat: Primer, galvanized, water based, MPI #134.

    b. Intermediate Coat: Latex, exterior, matching topcoat.

    c. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

    d. Topcoat: Latex, exterior, semi-gloss (MPI Gloss Level 5) MPI #11.

        1) <Insert manufacturer's name; product name or designation>.

E. Aluminum Substrates:

1. Latex System MPI EXT 5.4H:

    a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.

    b. Intermediate Coat: Latex, exterior, matching topcoat.

    c. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

    d. Topcoat: Latex, exterior, semi-gloss (MPI Gloss Level 5), MPI #11.

F. Portland Cement Plaster Substrates:

1. Latex System MPI EXT 9.1A:

    a. Prime Coat: Latex, exterior, matching topcoat.
    b. Prime Coat: Primer, alkali resistant, water based, MPI #3.

    c. Intermediate Coat: Latex, exterior, matching topcoat.
    d. Topcoat: Latex, exterior, flat (MPI Gloss Level 1), MPI #10.

    e. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.

1.3 DEFINITIONS

A. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

B. PAINT - (PNT):
   1. PNT-E: Water-based epoxy paint for gypsum board and/or concrete block walls/partitions and/or concrete walls.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

A. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. Floor Coatings: VOC not more than 100 g/L.
5. Shellacs, Clear: VOC not more than 730 g/L.
6. Shellacs, Pigmented: VOC not more than 550 g/L.
7. Flat Topcoat Paints: VOC content of not more than 50 g/L.
8. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
9. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
10. Floor Coatings: VOC not more than 100 g/L.
11. Shellacs, Clear: VOC not more than 730 g/L.
12. Shellacs, Pigmented: VOC not more than 550 g/L.
13. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.

B. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Colors: As selected by Owner from manufacturer's full range.

1. Ten percent of surface area will be painted with deep tones.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Fiber-Cement Board: 12 percent.
3. Masonry (CMUs): 12 percent.
4. Wood: 15 percent.
5. Gypsum Board: 12 percent.
6. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.

F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

G. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer**.**

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.
h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:

a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.

g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

PNT-E: PRE-CATALYZED WATER BASE EPOXY - SEMI-GLOSS, where scheduled for "GB" (Gypsum Board)

A. System: Primer plus two finish coats as specified below:

B. Prime Coat:
1. Benjamin Moore: Super Spec, 253.
2. PPG Paints: Speedhide Quick Drying Latex Sealer 6-2.
3. Sherwin-Williams: PrepRite 200, B28W200.

C. Two Finish Coats at 5 to 6 mils total DFT:
1. Benjamin Moore: Corotech Semi-Gloss Pre-Catalyzed Epoxy, V341 series.
2. PPG Paints: Pitt-Glaze WB1 Pre-Catalyzed Water Based Epoxy Semi-Gloss

3. Sherwin-Williams: Pro-Industrial Pre-catalyzed Water based Epoxy, K46W51 series.

PNT-E: PRE-CATALYZED WATER BASE EPOXY - SEMI-GLOSS, where scheduled for "CMU" (Concrete Block) in Dry areas

A. System: Filler plus two finish coats as specified below:

B. Filler Coat: Provide block filler at rate to provide PINHOLE-FREE SURFACES.
   1. Benjamin Moore: Moorcraft S-H Latex Filler, 285.
   2. PPG Paint: Speedhide Int/Ext Hi-Fill Latex Block Filler 6-15.
   3. Sherwin-Williams: PrepRite, B25W25.

C. Two Finish Coats at 5 to 6 mils DFT:
   1. Benjamin Moore: Corotech Semi-Gloss Pre-Catalyzed Epoxy, V341 series.
   2. PPG Paints: Pitt-Glaze WB1 Pre-Catalyzed Water Based Epoxy Semi-Gloss
   3. Sherwin-Williams: Pro-Industrail Pre-catalyzed Water based Epoxy, K46W51 series.

PNT-E: PRE-CATALYZED WATER BASE EPOXY - SEMI-GLOSS, where scheduled for "CONC" (Poured Concrete) in Dry areas

A. System: Primer plus two finish coats as specified below:

B. Primer Coat:
   1. Benjamin Moore: High Build Acrylic Masonry Primer 068.
   2. PPG Paint: Perma-Crete Alkali Resistant Primer 4-603.
   3. Sherwin-Williams: Loxon Acrylic Primer A24W300.

C. Two Finish Coats at 5 to 6 mils DFT:
   1. Benjamin Moore: Corotech Semi-Gloss Pre-Catalyzed Epoxy, V341 series.
   2. PPG Paints: Pitt-Glaze WB1 Pre-Catalyzed Water Based Epoxy Semi-Gloss
   3. Sherwin-Williams: Pro-Industrail Pre-catalyzed Water based Epoxy, K46W51 series.

END OF SECTION 099123

SECTION 101400 - SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior Signage

1.02 QUALITY ASSURANCE

A. Signs shall be designed and installed for use by handicapped persons in accordance with ANSI A117.7

1.03 SUBMITTAL

A. Submit shop drawings listing sign size, letterform and letter heights.

B. Submit manufacturer's technical data and installation for each type of sign required.

C. Submit one full size sample sign of type, style and color specified, including method of attachment.

D. Submit suppliers standard color samples for purposes of color selection and verification. Color samples must be actual materials used in signage, printed color charts are not acceptable.

E. Manufacturers must submit 3 references showing products for projects completed within the last 5 years.

F. Submit copy of manufactures product warranty.

G. Refer to specification Section 01 8113 Part 1.5 for LEED product submittal requirements.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Century Sign Builders. (Basis of Design).

B. Sign Source

C. Best Signs

D. Manufacturers of equivalent products submitted and approved in accordance with Section 01 60 00 - Product Requirements.

2.02 Fabrication.

A. Signs shall have the following characteristics:

1. Tactile characters/symbols shall be raised 1/32" from sign plate face.
2. Text shall be accompanied by Grade 2 braille on signs requiring braille.
3. All letters, numbers and/or symbols shall have a 70% contrast to the plaque color of the sign as required by ADA regulations.
4. Sign plaques, lettering, and symbols shall have a matte or eggshell finish
5. Sign plaques, letters, and symbols must be constructed with materials having embedded coloration that is the final approved color for the signs. Products with painted or otherwise applied coloration method are not acceptable.

B. Sign plaque, letters and symbols shall be constructed using 0.125” single ply non-glare acrylic multipolymer material with either continuous embedded pigment or a micro-surfaced color layer. (depending on color selection)

C. Tactile lettering and symbols shall be formed using rotary engraving method and bonded to sign plaque using 3M Scotch 467HP adhesive. Lettering and symbols must have 1/32” return cut to 22 degree angle. Lettering and symbols must conform to material standards in section 2.02 B (above) of this specification guide.

D. Lettering style and size will be in accordance with design format in Century Sign Builders product line [CS]

E. Signs requiring Braille must be constructed using the Edgerton Grade 2 Braille System.

F. Sign made of applied vinyl letters shall have the following characteristics

1. Use only high performance cast vinyl graphic films
2. Must be fabricated in a manner that produces clean letter forms.
    1. No hand cut lettering may be used

G. Provide submittals as required by Section 01 8113 Supplemental Table:
1. Submittal Requirements for LEED v4 Materials and Resources Credits.

2.03 SIGN DESIGN

A. Reference NMSU Signage standards. Available from NMSU.

PART 3

3.1 INSTALLATION

A. Panel signs shall be mounted (4) course thread drywall screws (one in each corner). Screws shall be of a bugle head type, and be received by counter-sunk area on the face of the sign such that the head of the screw is flush with the face of the sign.

a. If a sign should need to be mount on an interior window (side light). Apply a 5.5” x 7.5” patch of graphic vinyl film (color selected by Section 1) to the surface

of glass, then mount sign (as above) to vinyl patch in such a way that mounting method is not visible from interior of room.

B. All signs shall be mounted 60" from the floor to the center of the sign on the latch side of the door. The distance between the door frame and edge of the sign should be 2".

C. If condition 3.1 B cannot be met notify Architect, approval may be given to install in alternate location.

D. Sign made of applied vinyl letters must be installed on surfaces in such a way that they are level and free from air bubbles as observed from a distance of greater than 36”

3.2 CLEANING AND PROTECTION

A. Repair scratches or other minor damage which might have occurred during installation.

B. Clean installed signage using only manufacturer recommended products

C. Remove any construction debris or trash as per Division 1.

3.3 CLOSE OUT DOCUMENTATION

A. Provide copy of manufacturer’s recommended care and cleaning methods

B. Provide written copy of manufacturer’s warranty and contact.

3.4 WARRANTY

A. Interior signage must be provided with an unconditional manufacturer’s building lifetime warranty.

3.5 SCHEDULE

A. See Section ‘10 14 00 – SIGNAGE SCHEDULE’ following this section.

3.6 SIGN TYPES

A. See SIGN TYPE profiles following this section

END OF SECTION - 101400

SECTION 10 2600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Corner guards.

B. Crash rails

1.03 REFERENCES

A. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 1997.

1.04 PERFORMANCE REQUIREMENTS

A. Corner Guards: Resist lateral impact force of 100 lbs at any point without damage or permanent set.

1.05 SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures.

B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.

C. Samples: Submit two sections of corner guard, 12 inch long, illustrating component design, configuration, color and finish.

1.06 QUALITY ASSURANCE

A. Fire Resistance: Where fire ratings are specified for components, provide assemblies that have been tested and rated in accordance with ASTM E 119.

1.07 PROJECT CONDITIONS

A. Coordinate the work with wall or partition sections for installation of concealed blocking or anchor devices.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Wall and Corner Guards:

1. C-Sgroup.com
2. Construction Specialties, Inc.
3. InPro Corporation
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Crash Rails:

1. C-Sgroup.com/Acrovyn-wall-protection
3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

A. Corner Guard - Surface Mounted: Extruded one-piece unit, installed with screws. Typical at all exposed corner locations throughout the renovation and addition.

1. Material: Stainless Steel.
2. Size: 4 inches both sides by 4'-0" high.
3. Length: One piece.

B. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.

C. Crash Rails:

1. Basis of Design- Model SCR 80, 5" high , surface mounted crash rail wall protection, to protect carts from damaging wall.

2. Length: varies, see plans

3. Mounting brackets and hardware: Appropriate to component and substrate.

3. Color: To be selected by OWNER from manufacturer standard colors.

4. Mounting Height: 36" AFF

2.03 FABRICATION

A. Fabricate components with tight joints and seams.

B. Pre-drill holes for attachment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that rough-in for components are correctly sized and located.

B. Verify that field measurements are as indicated on Drawings.

3.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

B. Position corner guard 4” above finished floor or immediately on top of finished base.

C. All outside corners within the new construction typical and as indicated on the drawings.

END OF SECTION 102600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Washroom accessories.
2. Shower room accessories.

B. Related Requirements:

1. Section 088300 "Mirrors" for frameless mirrors.
2. Section 093013 "Ceramic Tiling" for ceramic toilet and bath accessories.

1.3 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.

B. Samples: Full size, for each exposed product and for each finish specified.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, visible silver spoilage defects.
2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED MATERIALS

A. Owner-Furnished Materials: Toilet Paper Dispensers, Paper Towel Dispensers, Soap Dispensers,

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PUBLIC-USE WASHROOM ACCESSORIES

A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
1.

B. Waste Receptacle
1. Mounting: Freestanding
2. Minimum Capacity: 16 Gallon
3. Material and Finish: Stainless steel, No. 4 finish (satin).
4. Liner: none
5. Lockset: None.

C. Grab Bars:

1. Mounting: Flanges with concealed fasteners.
2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.

    a. Finish: Smooth, No. 4 finish (satin).

3. Outside Diameter: 1-1/2 inches (38 mm).
4. Configuration and Length: As indicated on Drawings.

D. Mirror Unit:

1. Frame: Stainless-steel angle, 0.05 inch (1.3 mm) thick.

    a. Corners: Welded and ground smooth.

2. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.

    a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
    b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

3. Size: 24” W x 36” H.

E. Clothes Hook :

1. Description: Single-prong, heavy duty, concealed mounting unit.
2. Material and Finish: Stainless steel, No. 4 finish (satin).

F. Shower Rod :

1. Description: Length to fit openings; stainless steel, satin finish, surface mount with concealed wall brakcets. Heavy duty, 20 gauge

G. Shower Curtain:

1. Description: Privacy curtain, commercial rated, with nickel-plated brass grommets; 72” wide by 70” tall. Vinyl, opaque coated to be resistant to flames.

H. Sanitary Napkin Disponsal:

1. Description: Top loading, 1.2 gallon capacity with 22 gauge, type 304 stainless steel. Full length piano hinge. Depth to be less than 4”.

I. Folding Shower Seat:

1. Description: 30”x16” ½” thick fire and mildew resistant Phenolic, Rectangular, Fold Down Shower Seat with 18 gauge type 304 stainless steel tubing legs.

J. Mop Rack:

1. Description: Four stainless steel hooks; Three spring loaded rubber cam holders with an anit-slip coating and 18 gauge stainless steel shelf above. Length 34 to 48 inches.

K. Toilet Seat Cover:

1. Description: 15 ¾” x 11 ¼”; holds single or half-fold paper toilet seat covers, capacity 250 covers. Type 304 Stainless Steel. Surface Mounted over toilet.

L. **Surface Mounted Paper Towel Dispenser**: Owner Furnished, Contractor Installed.

M. **Surface Mounted Soap Dispenser:** Owner Furnished, Contractor Installed.

N. **Tissue Dispenser:** Owner Furnished, Contractor Installed.

PRODUCT DATA SHEET 1 - MATERIALS

A. Stainless Steel: ASTM A666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.

B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.

C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 (Z180) hot-dip zinc coating.

E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of [six] <Insert number> keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 10 4400 - FIRE EXTINGUISHERS & CABINETS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fire extinguishers.

B. Fire extinguisher cabinets.

C. Mounting Brackets

D. Accessories.

1.2 RELATED SECTIONS

A. Section 06 1000 – Rough Carpentry.

1.3 REFERENCES

A. NFPA 10 - Standard for Portable Fire Extinguishers; National Fire Protection Association; current edition.

B. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.4 PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10.

B. Provide Extinguisher and Cabinet from single manufacturer

C. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for the purpose specified and indicated.

1.5 SUBMITTALS

A. See Section 01 3300 – Submittal Procedures.

B. Product Data: Provide color and finish and anchorage details.

C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fire Extinguishers, Cabinets and Accessories:

1. JL Industries, Inc.
2. Larsen's Manufacturing Co.
3. Potter-Roemer.
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FIRE EXTINGUISHERS

A. Five (5) pound multi-purpose chemical type fire extinguishers; MP-5 by Larsen's Manufacturing.

1. Location: All areas, except Kitchen.

B. Wet-Chemical Type : UL-rated 2-A:1-B:C:K, 1.6-gal. (6-L) nominal capacity, with potassium acetate based chemical in stainless-steel container; with pressure-indicating gage. Basis of Design: Larsen’s Manufacturing Co. WC-6L – mounted on standard surface mounted bracket 1007.

1. Location: See plans

2.3 FIRE EXTINGUISHER CABINETS

A. Cabinet Configuration: Semi-recessed type: Larsen 2409-6R at non-rated walls, FS 2409-6R at fire-rated walls. Fully-recessed type: 2409-R2. Surface mounted: 2409-SM.

1. Cabinet box: 9 1/2 by 24 by 6 inches formed steel box, 18 gage with white baked enamel finish.
2. Trim: Returned to wall surface with 2 1/2" rolled edges for semi-recessed type; 5/16” rolled edges for fully recessed type.
3. Form cabinet enclosure with right angle inside corners and seams. Form perimeter trim and door stiles.

B. Door: 0.036 inch thick, reinforced for flatness and rigidity; lock with break glass access. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.

C. Door Glazing: Full Glass, clear, 1/8 inch thick float. Set in resilient channel gasket glazing.

D. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.

E. Weld, fill, and grind components smooth.

F. Finish of Cabinet Exterior Trim and Door: Baked enamel, white color suitable for field painting.

G. Finish of Cabinet Interior: White enamel.

2.4 ACCESSORIES

A. Extinguisher Brackets: Formed steel, chrome-plated.

B. Signage:
1. Identify fire extinguisher in cabinets with "FIRE EXTINGUISHER" lettering applied to door. Provide letter in size, style and location per jurisdictional authorities requirements.
2. Identify bracket-mounted fire extinguishers with "FIRE EXTINGUISHER" in red letter decals applied to wall surface. Use letter size, style and location as directed by Architect.
3. Identify valve cabinets with "FIRE DEPARTMENT CONNECTION" lettering applied to door glazing. Provide letter in size, style and location per jurisdictional authorities requirements

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cabinets plumb and level in wall openings, 48 inches from finished floor to fire extinguisher operating mechanism.

C. Secure rigidly in place.

D. Place extinguishers in cabinets or on surface mounted brackets where noted.

E. Position cabinet signage as noted in Part 2.

3.3 SCHEDULES

A. Provide where indicated on the Drawings and as noted in subparagraph 2.02 of this Section.

END OF SECTION 10 4400

SECTION 11 13 00

LOADING DOCK EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Loading dock equipment of the following types:
   1. Dock bumpers.

1.2 RELATED SECTIONS

A. Section 03 11 19 - Insulating Concrete Forming.

B. Section 03 30 00 - Cast-in-Place Concrete.

C. Section 05 50 00 - Metal Fabrications.

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI MH30.3 - Vehicle Restraining Devices (Safety, Performance, and Testing).

1.4 SUBMITTALS

A. Section 01 33 26 - Source Quality Control Reporting.

B. Product Data: For each product specified. Indicate unit dimensions, method of anchorage, and details of construction. Indicate materials and finish, installation details, roughing-in measurements, and operation of unit.

C. Shop Drawings:
   1. Indicate required opening dimensions, tolerances of opening dimensions, placement dimensions, and perimeter conditions of construction.
   2. Wiring diagrams including location of control stations and disconnect switches.

D. Assurance/Control Submittals:
   1. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
   2. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Manufacturer specializing in manufacturing Products specified with minimum 30 years' experience.
   2. Manufacturer to have quality assurance improvement programs and ISO certified.
   3. Manufacturer shall be associated with Loading Dock Equipment Manufacturers (LODEM) setting ANSI standards.
   4. Manufacturers welding procedure compliant with A.W.S.D1.1 specifications.

B. Installer Qualifications: Company specializing in performing the Work of this Section with minimum 5 years' experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations and industry standards. Store materials within absolute limits for temperature and humidity recommended by manufacturer. Protect from damage.

B. Store products in manufacturer's labeled packaging until ready for installation.

1.7 WARRANTY

A. Warranty: Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Grainger, www.grainger.com

B. Substitutions: See section 01 6000 Product Requirements

2.2 Loading Dock Bumpers

A. Dock Bumper: To absorb impact and protect loading dock surface from delivery damage.
   1. Laminated Rubber Rectangular Dock Bumper
      a. Height: 10”
      b. Length: 26”
      c. Quantity: 3
      d. Mounting Height: Per manufacturer recommendation

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not proceed with installation until substrates have been properly prepared and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.

B. Prepare substrates using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

D. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

3.2 INSTALLATION

A. Install products in prepared opening in accordance with manufacturer's instructions. Set square and level. Anchor unit securely, flush with dock. Weld back of dock leveler to pit frame. Touch-up welds with matching paint.

B. Install dock bumpers in accordance with manufacturer's instructions.

3.3 ADJUSTING

A. Adjust installed unit for smooth and balanced operation.

END OF SECTION

SECTION 11 5300

LABORATORY EQUIPMENT AND APPLIANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Contractor-furnished laboratory equipment including CFOI equipment installed by Owner.

B. Installation of Contractor-furnished (CFCI) equipment.

C. Installation of Owner-furnished (OFCI) equipment.

D. Coordination with Owner-furnished Owner-installed (OFOI) equipment.

1.02 RELATED REQUIREMENTS

A. Section 01 2300 - Alternates: Descriptions of items, administrative requirements.

1.This section describes basic features of pieces of equipment, as well as their accessories. Alternates section defines which of these are to be included in the base bid, and which are required to be priced separately.

B. Section 10 5100 – Phenolic Lockers

C. Section 11 5380 – Dry Heat Sterilizer

D. Section 11 5350 – Environmental chamber

C. Section 12 3553 – Laboratory Casework

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 01 2100 - Allowances, for cash allowances affecting this section.

B. Allowance includes purchase and delivery of particular scheduled laboratory equipment. Installation is not included in the allowance but is specified in this section and is part of the Contract Sum/Price.

C. Allowance includes purchase, delivery, and installation of particular scheduled laboratory equipment.

1.04 ABBREVIATIONS AND ACRONYMS

A. OFOI - Owner Furnishes and Owner Installs.

B. CFOI - Contractor Furnishes and Owner Installs.

C. OFCI - Owner Furnishes and Contractor Installs.

D. CFCI - Contractor Furnishes and Contractor Installs.

1.05 REFERENCE STANDARDS

A. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2021.

B. ASME BPVC - Boiler and Pressure Vessel Code; 2021.

C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2020a.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2020.

E. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

F. ASTM A879/A879M - Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface; 2012 (Reapproved 2017).

G. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2021a.

H. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

I. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

J. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2019.

K. NAAMM AMP 500-06 - Metal Finishes Manual; 2006.

L. NEMA MG 1 - Motors and Generators; 2014.

M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate installation of laboratory equipment with laboratory casework and Owner-furnished, Owner-installed laboratory equipment.

B. Preinstallation Meeting: Convene one week before starting work of this section.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.07 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide equipment dimensions and construction; equipment capacities; physical dimensions; utility and service requirements, clearances, and locations; required accessories and optional features.

C. Shop Drawings: Indicate equipment locations, large scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, installation and servicing clearances required.

D. Samples: Where applicable, submit finish option samples,6 by 6inch in size illustrating color and finish.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Test Reports: Factory tests for each type of equipment.

G. Manufacturer's Installation Instructions: Indicate special installation requirements.

H. Manufacturer's Qualification Statement.

I. Installer's Qualification Statement.

J. Operation Data: Include description of equipment operation and required adjusting and testing .

K. Maintenance Data: Identify system maintenance requirements, servicing cycles, lubrication types required and local spare part sources.

L. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

M. Project Record Documents: Record actual locations of concealed utility connections.

1.08 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience and approved by manufacturer.

C. Preconstruction Testing: Factory-test each type of equipment.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Package each piece of equipment to ensure protection from damage during shipment and delivery. Legibly indicate on the exterior of each container or crate, the shipping address and a brief description of its contents. Outside of the container, fasten a waterproof envelope containing a packing list and complete instructions for uncrating and setting the equipment in place.

B. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.10 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. See equipment schedule end of this section.

2.02 EQUIPMENT

A. Equipment: Scheduled at end of this section.

B. Owner furnishes and installs equipment noted as OFOI.

C. Owner furnishes and Contractor installs equipment noted as OFCI.

D. Contractor furnishes and installs equipment noted as CFCI.

E. Contractor furnishes and Owner installs equipment noted as CFOI.

F. Each item energized by a single switch.

G. Prewire and prepipe each unit of equipment complete with trim and fittings. Include reduced pressure or atmospheric type backflow preventer fitting to prevent backflow of polluted water or waste into water supply system or equipment. Comply with applicable code requirements.

H. Affix a securely attached plate which includes the manufacturer's name, address, and catalog or serial number to each equipment item. If applicable, include pressure vessels bearing the ASME stamp and pressure rating, indicating compliance with applicable code requirements.

I. Installation Accessories: Provide all rough-in frames, anchors, supports, accessories and closure trim required for complete installation.

J. Use corrosion-resistant materials for all rivets, bolts, nuts, studs, spacers, and welding metal.

K. Fully assemble equipment in factory, except for those items which cannot be moved to their final locations as single item due to new construction space restrictions.

2.03 EQUIPMENT SCHEDULE

A. Equipment numbers in this schedule coordinate with the Equipment plan and schedule on sheet EQ-101 in the drawings.

B. Basis of Design manufacturer listed for each item in Equipment List below. For Substitution Requests during or after bid phase, see section 01 2500 for instruction. In addition, contractor shall submit CSI Substitution Request form to Architect for review.

C. Contractor to coordinate quantities with quantities shown on sheet EQ-101. If there is a discrepancy in quantities between this Equipment Schedule and equipment shown on the equipment plan the equipment plan takes precedence.

D. Equipment list, coordinate with Equipment Plan and Schedule in the drawings.

EQUIPMENT SCHEDULE, *COORDINATE WITH SHEET EQ-101

Equipment No. 1: Not Used

Equipment No. 2: Fume Hood

1. Description: Fume Hood, 4’ wide, with epoxy resin work surface, standard glass reinforced polyester liner, pre-piped and pre-wired, acid and flammable storage cabinet below.
2. Manufacturer: Kewaunee, www.kewaunee.com
3. Model: General Purpose Bench Supreme Aire Fume Hood
4. Size: 48”l x 36”d x 97”h
5. Material: 304 Stainless Steel
6. Mounting: Free-Standing *with fixed utility connections
7. Accessories and Options:
8. Utility Requirements:
    a. Electrical- 445 W, 115V/ 60 Hz
    b. Mechanical- Exhaust
    c. Plumbing- Water and drain
9. Accessories: Ceiling Closure

Equipment No. 3: Fume Extraction Arm

1. Description: Wall or ceiling mounted Individual fume extraction system at- source of the pollutant to prevent spread of polluted air into surroundings suitable for laboratories.
2. Manufacturer: Alsident, www.alsident.com
3. Model: System 75-6555-3-
4. Size: Wall-and- Ceiling Mounted 3 Joint 48.43” reach
5. Hood Type: Clear Hood, Dia 385/15, 1-7535-
6. Material: Aluminum
7. Capacity: 45-105 CFMs
8. Mounting: Fixed mounting *with fixed utility connections
9. Accessories and Options: Wall Bracket
    a. Utility Requirements:
    b. Electrical: 445 W, 115V/ 60 Hz
    c. Mechanical- Ventilation

Equipment No. 4: Dry Heat Sterilizer

1. See Section 11 5380 Laboratory Equipment- Dry Heat Sterilizer
2. *Coordinate with the ClorDisys equipment.

Equipment No. 5: Environmental Chamber

1. See Section 11 5350 Laboratory Equipment- Environmental Chamber

Equipment No. 6: Refrigerator with Drawer Freezer

1. Description: Refrigerator with Drawer Freezer Below
2. Manufacturer: Hisense, www.heisense.com
3. Model: 17.2 cu counter-depth bottom freezer #HRB171N6ASE
4. Size: 31X27X70
5. Material: Stainless Steel
6. Mounting: Free standing
7. Provided by Installed by: OFOI
8. Utility Requirements:
    a. Electrical- Power Outlet

Equipment No. 7: Animal Transfer Station

1. Description: Animal transfer station with Active Barrier Containment system, and touchscreen with programmable variable height and light adjustment.
2. Manufacturer: Allentown, www.allentowninc.com
3. Model: Phantom2
4. Size: 32”d x 52” w x 87”h
5. Material: Stainless Steel type 304
6. Weight: 493 lbs
7. Mounting: Free-standing
8. Provided by Installed by: OFOI
9. Accessories and Options:
    a. Front Shelf
    b. End Shelf
10. Utility Requirements:
    a. Electrical- 273 Watts, 100-115v, 50/60 Hz, 208-230v, 50/60 Hz, coordinate with electrical drawings

Equipment No. 8: Electric Range with Oven

1. Description: Slide-in residential electric range with oven
2. Manufacturer: Frigidaire
3. Model: 30” Slide- in electric range, 5.3 cu oven capacity #FFEH3054U
4. Size: 37 ¼”h x 29 7/8” w x 28 ¼” D
5. Material: Stainless Steel
6. Mounting: Free Standing slide-in
7. Provided by Installed by: OFOI
8. Utility Requirements: 240V/208V/60 Hz, 40 Amps

Equipment No. 9: Laboratory Freezer -80deg

1. Description: Laboratory, Ultra low Temp freezer for
2. Manufacturer: ThermoScientific, www.fishersci.com
3. Model: Ultra-Low Temperature -80degree
4. Size: 28x 23x51
5. Material:
6. Mounting: free standing
7. Utility Requirements:
    a. Electrical: 208-230 V 60 Hz

Equipment No. 10: Washer, Electric

1. Description: Electric Washer
2. Manufacturer: GE
3. Model: GE 5.3 CU FT Smart Front Load Steam Washer
4. Mounting: free standing
5. Utility Requirements:
    a. Electrical
    b. Plumbing

Equipment No. 11: Dryer, Electric

1. Description: Electric Dryer
2. Manufacturer: GE
3. Model: GE 7.8 Smart Front Load Electric Dryer
4. Mounting: free standing
5. Utility Requirements:
    a. Electrical

Equipment No. 12: Stainless Steel Worktable

1. Description: Stainless Steel Worktable with wheels
2. Manufacturer: Omcan
3. Model: General Lab Procedure Table 17579
4. Mounting: free standing
5. Size: 24” x 36” x 34”tall

Equipment No. 13: Biological Safety Cabinet, 4 Foot

1. Description: Biological Safety Cabinet/ Cage changing station for sensitive animal handling and cage changing procedures. 4’ nominal width, Adjustable height with large access opening.
2. Manufacturer: Nuaire, www.nuaire.com
3. Model: NU-540-400 Class II Type A2 4’, or equal
4. Size: 77 5/8w x 32 ¾ d x 97.5h x
5. Material: 16 ga, type 304 stainless steel
6. Mounting: Free-Standing *with fixed utility connections
7. Accessories and Options:
    a. Single feed hopper, Ultraviolet light.
8. Utility Requirements:
    b. Electrical- 445 W, 115V/ 60 Hz, coordinate with electrical drawings
    c. Mechanical- Exhaust, coordinate with mechanical drawing

Equipment No. 14a: IVC Rack- Mouse *(Individually Vented Cage Rodent Housing)*

1. Description: Positive or Negative Precision controlled cage rodent housing rack. Lightweight, compact, row and column configuration. Accommodates NexGen Mouse900 reusable and Easy Cage single-use cages. Touchscreen with Night-

mode feature, monitorable system with Pre-filters that are washable and reusable, Noise and vibration reduction, HEPA filtration.

2. Manufacturer: Allentown, www.allentowninc.com
3. Model: Nexgen Mouse 900 45 cage
4. Size: 35”d x 69”w x 78”h
5. Material: Caged air-tubes stainless steel 304.
6. Weight: 765 lbs
7. Capacity: 45 cage
8. Mounting: Free- Standing *with fixed utility connections
9. Provided by Installed by: OFOI
10. Accessories and options:

a. Hydropac top
b. Cage
c. Wire Bar Lid WBL
d. Card holder, Horizontal
e. Basket and Bottle compartment

11. Utility Requirements:

a. Electrical- 40 CFMs Supply Air, 115V and 230V, coordinate with electrical drawings.
b. Mechanical- Exhaust connection and supply connection, coordinate with mechanical drawings.

Equipment No. 14b: IVC Rack- RAT *(Individually Vented Cage Rodent Housing)*

1. Description: Positive or Negative Precision controlled cage rodent housing rack. Lightweight, compact, row and column configuration. Accommodates NexGen Rat900 reusable and Easy Cage single-use cages. Touchscreen with Night-

mode feature, monitorable system with Pre-filters that are washable and reusable, Noise and vibration reduction, HEPA filtration.

2. Manufacturer: Allentown, www.allentowninc.com
3. Model: Nexgen Rat 900, 35 cage
4. Size: 24”d x 65”w x 78”h
5. Material: Caged air-tubes stainless steel 304.
6. Weight: 530 lbs
7. Capacity: 35 cage
8. Mounting: Free- Standing *with fixed utility connections
9. Provided by Installed by: OFOI
10. Accessories and options:

a. Hydropac top
b. Cage
c. Wire Bar Lid WBL
d. Card holder, Horizontal
e. Basket and Bottle compartment

11. Utility Requirements:

a. Electrical- 40 CFMs Supply Air, 115V and 230V, coordinate with electrical drawings.
b. Mechanical-Exhaust connection and supply connection, coordinate with mechanical drawings.

Equipment No. 15: Not Used

Equipment No. 16: -4 Lab Fridge, Below Counter

1. Description: Laboratory Refrigerator
2. Manufacturer: Thermoscientific
3. Model: TSV05RPAA ADA Lab Refrigerator 5.5 CU
4. Utility Requirements- Electrical

Equipment No. 17: -20 Lab Freezer, Below Counter

1. Description: Laboratory Freezer
2. Manufacturer: Thermoscientific
3. Model:02LFEETSA, 1.8 cu ft

4. Temperature Range: -12 Deg C to -20 Deg C

Equipment No. 18: Cryostat

1. Description: Machine to maintain low cryogenic temperatures of tissue samples.
2. Manufacturer: Leica CM 1950 Cryostat
3. Utility Requirements: Electrical

Equipment No. 19: Glove Box

1. Description: Sealed container with gloved arm holes to allow manipulation of objects in a controlled atmosphere.
2. Manufacturer: Labconco
3. Model: Protector Combination Glove Box, with rolling stand.
4. No of Glove Ports: Four
5. Utility Requirements: Electrical

Equipment No. 20: Post Mortem Room Equipment, *multiple equipment

1. *Equipment is existing and to be relocated. See Drawings for additional information.

Equipment No. 21: Microscopes

1. Xxxxxxxx TBD BY NMSU

Equipment No. 22: Bird & Bat Cages

1. xxxxxxxxxx TBD BY NMSU

Equipment No. 23: Reverse Osmosis, Table Top unit

1. Description: Table top ultra pure water filter Reverse Osmosis system (RO), designed to be connected to tap water source, with water tank system.
2. Model: Milli-Q EQ 7008/7016, with 25L storage tank.
3. Utility Requirements:

a. Plumbing,

b. Electric

4. Product features: smart touchscreen, usb data port, water storage tank, connects to domestic tap water and electrical, “bench-top” type unit, 3 flow rate volumetric dispensing, produces high quality ultrapure water.

Equipment No. 24: Heavy Duty 4-Post Shelving

1. Description: Heavy duty 4 post metal shelving with wire deck.
2. Manufacturer: Global Industries, www.globalindustrial.com
3. Model number: 255715 Extra Heavy Duty Shelving, 1200lb capacity
4. Size: 48 inches W x 24 inches D x 72 inches H

Equipment No. 25: Peg Board

1. Description: wall-mounted Pegboard, 32 pegs, stainless steel
2. Manufacturer: Raptor Supplies, www.raptorsupplies.com+-
3. Model number: GRV2430
4. Dimensions: 24w x 30h
5. Provided by Installed by: OFOI

Equipment No. 26: Flammable Storage Cabinet

1. Description: Flammable Safety Cabinet, Self close Safe-T door with 2 shelves
2. Manufacturer: Interstate Products, Inc, www.
3. Capacity: 45 Gallons
4. Size: 67”h x 43”w x 18” d
5. Weight: 357 lbs.
6. Provided by Installed by: OFOI

Equipment No. 27: Chest Freezer

1. Description: Ultra-Low Temperature laboratory chest freezer.

2. Manufacturer: LSR Cold Storage Solutions, www.lsfreezer.com
3. Model No: 11 Cu Ft Capacity, -50 deg C to -86 deg C temperature
4. Utility Requirements: Electrical
5. Features: Steel Cabinet chest, with External Lock and Temperature alarm, mobile on casters, and digital display.

Equipment No. 28: DISHWASHER

1. Description: Under-counter dishwasher
2. Manufacturer: GE
3. Model: 24" built-in dishwasher #FDG550PSRSS
4. Size: 24x32x24
5. Material: Stainless Steel
6. Mounting: Free-standing
7. Provided by Installed by: CFCI
8. Utility Requirements:
    a. Electrical- 120V, 60 Hz, 8.9A
    b. Plumbing- Water connection, drain

Equipment No. 29: MICROWAVE

1. Manufacturer: Whirlpool
2. Model: 1.6 cu ft 1200 Watt Coutertop microwave
3. Material: Stainless Steel
4. Utility Requirements: Electrical

Equipment No. 30: Chlorine Dioxide Gas Unit, *Portable for hook up to Dry Heat ` Sterilizer

1. Description: Chlorine Dioxide gas that provides safe effective way to decontaminate equipment. To be used as a plug-in piece of equipment with the Dry Heat Sterilizer. *Coordinate with Dry Heat Sterilizer Equipment.
2. Manufacturer: Clordisys

3. Model: Minidox M Unit, 30” w x 56” h x 29”d
4. Weight: 230 lbs
5. Utilities: Electrical

Equipment No. 31: O2 CANISTER STORAGE

1. Description: Oxygen cylinders with wall mount double bracket
2. xxxxxxx

Equipment No. 32: PHENOLIC LOCKERS

1. See section 10 5100 Phenolic Lockers

Equipment No. 33: PHENOLIC LOCKER BENCH

1. See section 10 5100 Phenolic Lockers

Equipment No. 34: ANTIVIBRATION TABLE

1. Description: Anti-vibration table for use in laboratory or metrology room to provide a suitable working condition for devices sensitive to shocks and vibrations.
2. Manufacturer: Cole Parmer, www.coleparmer.com
3. Model: Adam Equipment 104008036 Balance Antivibration table
4. Quantity: 1
5. Size: 32x24x31
6. Material: Aluminum frame
7. Mounting: Free standing

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that utility connections, rough-in frames, anchors and supports are accurately placed and deliver building services at specified characteristics and/or within acceptable functional ranges.

B. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Provide rough-in frame and anchors for placement of equipment where required.

3.03 INSTALLATION

A. Installation of equipment noted as OFOI or CFOI is by Owner. Coordinate those installations with work by Contractor.

B. Installation of equipment noted as OFCI or CFCI is by Contractor. Coordinate with equipment furnished and/or installed by Owner.

C. Install in accordance with manufacturer's instructions.

D. Install in accordance with standards required by authority having jurisdiction.

E. Large Components: Ensure that large components can be moved into final position without damage to other construction.

F. Mounting: Anchor equipment securely in place.

1. Mount equipment in compliance with SMACNA (SRM) requirements.

G. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner, and their locations are coordinated with equipment rough-in requirements.

1. Require manufacturer's installer to supervise connection to utilities being performed by mechanical and electrical trades.

2. Make connections between ferrous and nonferrous metallic pipe with dielectric waterways and flanges having temperature and pressure rating equal to or greater than that specified for the connecting piping. Use dielectric waterways internally lined with an insulator specifically designed to prevent current flow between dissimilar metals.

3. Connect steam lines on equipment to building source only after building steam lines have been cleaned of preservatives and materials that may be harmful to the equipment.

H. Touch-up minor damaged surfaces caused during installation. Replace damaged components as directed by Architect.

3.04 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of equipment with Mechanical, electrical, plumbing and other specialty equipment and/or fixtures.

3.05 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Where required, provide manufacturer's field representative to inspect installation of equipment.

C. Perform functional testing in accordance with referenced specification requirements. Test one item or similar model, as necessary or appropriate, to ensure that it is operational and installation complies with specification requirements.

D. Hydrostatic Testing: Test piping system at pressure of 1.5 times system operating pressure with water at temperature not exceeding 100 degrees F.

1. Before test, remove or isolate gauge traps and apparatus that may be damaged by that pressure.

2. Install calibrated test gauge in system to observe any loss of pressure.

3. Close off system and maintain test pressure not less the one hour. Inspect joints and equipment connections for leaks.

4. Retest and make repair until no further leaks are observed.

5. Manufacturer's standard equipment warranty shall not begin until the manufacturer certifies that equipment complies with required testing specified and until beneficial occupancy of portion of facility where equipment is installed.

6. Submit certified copies of results of factory tests of equipment tested.

7. Submit field test reports in booklet form showing field tests performed to adjust each component and field tests have been performed to confirm compliance with specified performance criteria, upon completion and testing of installed equipment.

a. Indicate in each test report the final position of controls.

3.06 ADJUSTING

A. Adjust operating equipment to efficient operation.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.

2. Conduct walking tour of project.

3. Briefly describe function, operation, and maintenance of each component.

E. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of two hours of training.

3. Instructor: Manufacturer's training personnel.

4. Location: At project site.

5. Location: Owner's offsite classroom facilities may be used.

6. Location: Provide local classroom facilities.

7. Location: At manufacturer's training facility; include travel expenses for one member of Owner's staff.

F. Final Acceptance: Remove labels, fingerprints, and clean all surfaces both inside and out. Repair any marred or damaged surfaces that affect appearance, such as both interior and exterior of cabinets in a manner acceptable to Owner. Replace any parts that cannot be repaired in such a manner.

3.08 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide a separate maintenance contract for specified maintenance service.

C. Provide a separate maintenance contract for the service and maintenance of large equipment for minimum 1 year from Date of Substantial Completion.

3.09 SCHEDULE

A. See drawings for Laboratory Equipment Schedule.

END OF SECTION

SECTION 11 53 13 – LABORATORY FUME HOODS AND RELATED PRODUCTS

PART 1: DESCRIPTION OF WORK

1.00 SUMMARY

Section Includes:
Based on Kewaunee Scientific Corporation's Supreme Air Venturi series fume hood design (V05F28_24" Interior Depth and 48" length), furnish and install all fume hoods, work tops, and understructures. Furnishing and installing all filler panels, knee space panels and scribes as shown on drawings.

Furnishing and delivering all service outlets, accessory fittings, electrical receptacles and switches, as listed in these specifications, equipment schedules or as shown on drawings. Plumbing fittings mounted on the fume hood superstructures shall be pre-plumbed per section 2.01.I. Electrical fixtures shall be pre-wired per section 2.01.J. The fume hood superstructure shall be listed to UL Standards for Safety by Underwriters Laboratories Inc. (UL). Final plumbing and electrical connections are the responsibility of those contractors fulfilling requirements of Divisions 15 and 16.

Removal of all debris, dirt and rubbish accumulated as a result of the installation of the fume hoods to an on-site container provided by others, leaving the premises clean and orderly.

Related Divisions:

1. Division 12: Laboratory Casework
2. Division 22: Plumbing
3. Division 23: HVAC
4. Division 26: Electrical

Related Publications:

1. ASHRAE Standard 110.2016 - Method of Testing Performance of Laboratory Fume Hoods
2. NIH03-112C - National Institute of Health Specification
3. UL - Underwriters Laboratories
4. ASTM D552 - Bending Test
5. NFPA-45 - National Fire Protection Association

1.01 BASIS OF WORK

A. It is the intent of this specification to use Kewaunee Scientific Corporation, Statesville, North Carolina, as the standard of construction for laboratory fume hoods. The construction standards of the Kewaunee Supreme Air Venturi fume hood shall provide the basis for quality and functional installation.

B. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval. This approval must be obtained seven (7) days before the proposal deadline.

C. General Contractors should secure a list of approved fume hood manufacturers from the architect as a protection against non-conformance to these specifications.

The owner/architect reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

Submittals:

1. Manufacturer's Data:
   Submit manufacturer's data and installation instructions for each type of fume hood. Provide data indicating ASHRAE Standard 110-2016 has been successfully completed per section 1.02.C, along with manufacturer's "As Manufactured" testing procedure.

2. Shop Drawings:
   a. Submit shop drawings for fume hoods showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings.
   b. Coordinate shop drawings with other work involved.
   c. Provide rough-in drawings for mechanical and electrical services when required.
   d. Provide face opening, air volume and static pressure drop data.

3. Non-Specified Manufacturer's Samples:
   A sample from each non-specified manufacturer will be required and reviewed per specification. This sample shall be delivered, at no cost to the architect/owner, to a destination set forth by the architect or owner. The sample must then be tested per section 1.02.C by an independent test agency hired by the submitting company and approved by the architect/owner. A passing test and architect/owner approval of the prototype must be written and approved seven (7) days before quotation deadline as a condition of acceptance for any quotation participant.

1.02 STANDARD FUME HOOD PERFORMANCE REQUIREMENTS

A. Fume hoods shall be Kewaunee's Supreme Air Venturi model with belted counterweight sash design and adjustable LED lighting. Sash and air entry framework of the hood shall minimize eddying of air currents at the hood face, and vertical rear baffle system shall minimize turbulence and vortexes in all portions of the hood interior.

Variable Air Volume (VAV) Fume Hood:
1. VAV Fume Hood designed to yield 100_FPM face velocity at 18" sash opening
2. Notched belt and sprocket sash system
3. Electronic sash stop at 18"
4. LED lighting, with variable intensity and color range

B. Face Velocities By Hood Design

Hood	Type	50 FPM	60 FPM	80 FPM	100 FPM	100 FPM	120 FPM
V05	Bench Vert Sash	●	●	●	●	●	●
V06	Bench Combo Sash	●	●	●	●	●	●

V07	Bench Horiz Sash	●	●	●	●	●	●
V10	Bench Split Sash	●	●	●	●	●	●
V11	Bench Split/Combo Sash	●	●	●	●	●	●
V15	ADA	●	●	●	●	●	●
V16	ADA Combo Sash	●	●	●	●	●	●
V25	LX Vert Sash		●	●	●	●	●
V26	LX Combo Sash		●	●	●	●	●
V30	LX Split Sash		●	●	●	●	●
V36	LX Split/Combo Sash		●	●	●	●	●
V40	Isotope					●	●
V45	Perchloric					●	●
V50	TruView Vert Sash	●	●	●	●	●	●
V51	TruView Combo Sash	●	●	●	●	●	●
V52	TruView ADA Vert Sash	●	●	●	●	●	●
V53	TruView ADA Vert Sash	●	●	●	●	●	●
V55	TruView Double-Sided Vert Sash	●	●	●	●	●	●
V56	TruView Double-Sided Combo Sash	●	●	●	●	●	●
V57	TruView Double-Sided ADA Vert Sash	●	●	●	●	●	●
V58	TruView Double-Sided ADA Combo Sash	●	●	●	●	●	●
V65	Floor Vert Sash			●	●	●	●
V66	Floor Combo Sash			●	●	●	●
V67	Floor Horiz Sash			●	●	●	●
V90	Distillation Vert Sash			●	●	●	●

C. Containment:

1. The purpose of this specification is to pre-qualify the performance of the bidder's laboratory fume hood before award of contract. At their option, owners or their representatives may

require the same tests to be performed and the same performance be achieved before acceptance of the hood after award of contract. The owner or their representative shall witness the tests. Failure to meet the performance specified shall be cause for rejection of the bidder.

2. Test Method:
   The hood shall be tested per the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 110-2016.

3. Location of Tests and Test Facility:
   All tests referenced herein shall be performed in the bidder's fume hood test facility. Field-testing is described in Section 3.F.01

   The test facility shall meet the following requirements:
   a. The test facility shall have sufficient area so that a minimum of 5 feet of clear space is available in front of and on both sides of the hood for viewing tests.
   b. The facility's ventilation system shall have adequate heating and air conditioning so that room air temperatures can be maintained within the desired ranges.
   c. Standard room air currents in the test area shall be less than 30 FPM.
   d. The hood exhaust system shall be properly calibrated so that the desired exhaust air volumes can be easily attained.
   e. Make-up air to the test room shall be ceiling-supplied as in a standard chemical laboratory.

4. Instrumentation, Equipment and Test Personnel:
   Qualified personnel to perform the tests shall be supplied by the bidder. Instrumentation and equipment required shall be supplied by the bidder at their expense. Required instrumentation shall include, but not be limited to, the following items:
   a. Thermal anemometer capable of measuring air velocities from 30 to 400 feet per minute (FPM) with an accuracy of +/- 3% of reading or +/- 3 FPM whichever is greater
   b. One-half minute smoke candles or other source of high volume smoke
   c. Smoke tubes or other source of localized smoke
   d. Miran 103 analyzer calibrated to indicate concentration of sulfur hexafluoride or equivalent.
   e. Tank of sulfur hexafluoride with a two-stage regulator or other tracer gas suitable for detector to be used
   f. Adjustable three dimensional mannequin, 4'-8” to 4'-10" in height, with reasonable human proportions and arms hanging at its side. Clothed in smock reasonably snug fitting garment typical of laboratory attire
   g. ASHRAE 110-2016 tracer gas ejector

5. ASHRAE Test (Choose One):

   Standard 110-2016 Test
   Hood shall be tested with a face velocity of 50 FPM (bench hoods only) with the sash at the maximum opening, 28”. The hood shall have a performance rating in the static portion of ASHRAE 110-2016 of AM 0.05 parts per million (PPM) or better wherein:

4.0	=	tracer gas release in liters/minute
AM	=	as manufactured
0.05	=	5-minute time average control level of tracer gas in PPM

1.03 QUALITY ASSURANCE

A. The laboratory fume hood manufacturer shall provide fume hood work tops and casework all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.

B. General Performance: Provide certification that fume hoods meet the performance requirements described in section 1.02.C.

PART 2 - PRODUCTS

2.00 MANUFACTURERS

A. The basis of this specification is the Supreme Air Venturi fume hood as manufactured by Kewaunee Scientific Corporation, 2700 West Front Street, Statesville, North Carolina.

B. All laboratory equipment covered by the specification shall be the product of one manufacturer and be fabricated at one geographic location to assure shipping continuity and single-source responsibility. All quotations from a manufacturer other than Kewaunee Scientific shall contain a review of the following capabilities:
   a. List of shop facilities
   b. List of engineering and manufacturing personnel
   c. Proof of financial ability to fulfill the contract
   d. List of a minimum of ten installations over the last five years of comparable scope
   e. Proof of project management and installation capabilities

C. The selected manufacturer must warrant for a period of one year starting with the date of acceptance or occupancy (whichever comes first) and that all products sold under the contract referenced above shall be free from defects in material and workmanship. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

2.01 MATERIALS AND CONSTRUCTION

C. Fume Hood Superstructure Frame:
A structure of steel support members shall be provided to support exterior panels and interior liner and baffle panels. To allow for maintenance and replacements, the baffle panels shall be removable without disassembly of the frame structure and outer steel panels. Likewise, the exterior steel panels shall be removable without disassembly of the frame structure and inner liner panels.

D. Fume Hood Side Walls:
Double wall end construction that shall not be more than 4.5" wide with sash track flush with front vertical fascia to provide maximum interior working area. This fascia shall contain space for the required service controls and electrical devices. The front vertical fascia shall be in a plane 45° from

the hood face and incorporate a Venturi port to provide accelerating air through the lower corners of the face opening.

E. Fume Hood Dimensions:
Double wall end panel thickness shall not exceed 4.5". Interior clear working height shall be not less than 48” at any location in the interior of the hood on bench hoods. Interior depth from the back of the sash to the front of the rear baffle shall not be less than 24”. The sash opening shall be not less than 28" in height above the work surface on bench hoods.

F. Sash Support System:
Fume hood sash support to employ notched belt and shaft interlocked gears. Belt to be Polyurethane with green polyamide fabric on notch side, 10mm wide x 5.6mm thick rated at 3600N tensile strength. Support system to be rated to 300,000 cycles (one cycle = one full up and one full down sash motion) without a failure. Sash support system to employ retainers to ensure sash remains level and square throughout use.

G. Fume Hood Airfoil:

Painted Steel
18-gauge painted steel, convergence z-cross section airfoil shall be mounted flush to the work surface immediately in front of the sash plane. It shall nest into the Venturi port on each side, and provide no open space between it and the top front edge of the worksurface. Raised airfoils, or flush designs that create openings within the hood chamber, are not acceptable.

H. Fume hood Top Panel:
Upper panel shall incorporate a Venturi-type dynamic barrier bypass providing a clean air stream behind the sash plane.

I. Fume Hood Baffles:
The fume hood baffles shall be fixed and constructed of the same material as the hood lining. They shall consist of multiple sections with vertical slots and a continuous horizontal slot at the worksurface. Each baffle panel shall be easily removable from the interior, without the use of tools, or requiring liner disassembly. Mechanical or manually adjustable baffles are not acceptable. Stainless steel baffles are designed as one unit with integrated baffle slots.

J. Fume Hood Duct Collar:

Stainless Steel – Each fume hood up to six feet in length shall contain one (1) 12” diameter 316 stainless steel duct collar in the hood roof for exhausting the hood. Fume hoods over six feet in length shall contain two (2).

K. Fume Hood Lighting:

1. An LED light fixture shall be provided in the hood roof. The light shall provide fifteen (15) intensity adjustment levels and three (3) color options. Illumination at the worksurface shall be at 100 foot-candles at the full intensity setting. The light fixture shall be isolated from the hood interior by a 1/4" thick tempered glass panel sealed from the hood cavity. Fixture shall be UL listed.

L. Sliding Safety Shield (Option S)

Fume hood to be provided with sliding safety shield that resides in front of the sash glass. Shield to be constructed of ¼" thick clear polycarbonate and to be 12" wide. Shield to slide the full length of the hood face opening on ball bearing rollers suspended from a track at the top of the sash opening, with a guide at the bottom to keep the shield from swinging. When the shield is not in use it can be easily removed from the upper track and stored.

M. Stainless Steel Sash Pull (Option Q)
Fume hood sash handle shall have two stainless steel handles used to open the sash. Pulls are to be type 304 stainless steel and are to be mechanically fastened to the sash handle.

N. Tissue Screen (Option T)
Fume hood to have tissue screen located behind the back baffle just above the safety slot. Tissue screen to be fabricated of perforated Type 304 stainless steel. Access to the tissue screen is by removing the back baffle.

O. Sash Glass:

Tempered Safety Glass (Option G2)
Fume Hood sash to be tempered safety glass.

P. Sash Stop Label (Option L)
Fume hood sash to be supplied with a label indicating the sash stop location. Label to be adhesive backed white vinyl with black print and easy to read.

Q. Fume Hood Vertical Sash:
A vertical rising sash of 1/4" laminated safety glass shall be provided. The sash shall have a neutral colored polyvinyl chloride horizontal member at the top and a painted full-length aerodynamic aluminum support rail with integral finger pull at the bottom. The sash shall be counterbalanced with a single weight to prevent tilting and binding during operation. The sash shall be connected to the counterweight system with two, 1/2" wide steel-reinforced polyurethane notched belts that engage two sprocket shaft drives.

Sash Heights

Sashes shall provide the following openings:

Series	Hood Type	Viewing Height	Opening Height	Sash Type
V05	General Purpose	38 ½”	28”	Vertical
V06	General Purpose	38 ½”	28”	Combination
V07	General Purpose	38 ½”	31”	Horizontal
V10	Split Sash	38 ½”	28”	Vertical – Split
V11	Split Sash	38 ½”	28”	Combination – Split
V15	ADA Hood	41 ½”	28”	Vertical
V16	ADA Hood	41 ½”	28”	Combination
V25	LX Series (Extra Height)	50 ½”	28” OR 35”	Vertical
V26	LX Series (Extra Height)	50 ½”	28” OR 35”	Combination
V30	LX Series (Extra Height/Length)	50 ½”	28” OR 35”	Vertical
V36	LX Series (Extra Height/Length)	50 ½”	28” OR 35”	Combination
V40	Isotope	38 1/2”	28”	Vertical
V45	Perchloric	38 ½”	28”	Vertical
V65	Floor Mounted General Purpose	74 ¾”	64 ¼”	Vertical
V66	Floor Mounted General Purpose	74 ¾”	64 ¼”	Combination
V67	Floor Mounted General Purpose	74 ¾”	68”	Horizontal
V90	Distillation	73 ½”	63”	Vertical

R. Fume Hood Services:
Front Mounted Remote Control Fittings:
Service fitting valves shall be needle valve design and mounted on the hood front vertical fascia with the working components of the valve accessible from the hood exterior. Valves shall be furnished with molded nylon hooded handles with color-coded index buttons and color-coded service outlet.

OPTIONAL
All plumbing fittings shall be factory installed and piped between the valve and the outlet. Inlet piping shall be carried to a point 6" above the fume hood roof or 6" below the work top rear corner

depending on the rough-in locations shown in the drawings. Points of final service connection by other trades shall be at the stub provided by the fume hood manufacturer.

S. Fume Hood Electrical Fixtures:
The hood superstructure shall be pre-wired in compliance with UL 61010A-1 and contain a UL label certifying acceptable wire gauge, connections, fixtures and wire color-coding. Electrical fixtures shall be specification grade and consist of two side-by-side duplex receptacles per vertical fascia, and a light switch. The receptacles shall be 20 Amp, 125 volt AC, and 3-wire polarized grounded. Each fascia shall be prewired to a single circuit and have a minimum of (1) ground fault interruption device. The light, light switches and electronic sash stop shall be low voltage. Final wiring and circuit dedication shall be by others.

Fan and Blower switch shall have a motor-rated starter switch with pilot light mounted in a single-gang receptacle box complete with face plate, 120-volt pilot light, and double-pole toggle switch with thermal overload protection for up to 1 HP single phase, 60 hertz 120/240-volt AC motors.

T. Hood Work surface:
Epoxy Resin:
Hood work surface shall be 1-1/4" thick molded epoxy resin made in the form of a watertight pan, not less than 1/2" deep to contain spillage. Top shall be manufactured at the same manufacturing location as the fume hood to assure proper cutout alignment and coordinated shipping.

A cup drain flush with the recessed work surface, or raised above the work surface shall be provided when shown.

U. Interior Service Access:
Access to services shall be through a trapezoid shaped gasketed panel constructed of the same material as the liner. The panel shall be easily removable without the use of tools.

V. Fume Hood Liners:
KEMGLASS Fiberglass Reinforced Polyester Lining:
Interior liner panels shall be 1/4" thick fiberglass reinforced polyester sheet. Interior liner panels shall be fastened using stainless steel screws with plastic covered heads. The material shall have an ASTM E84 Class A flame spread rating (25 or less).

W. Fume Hood Base Cabinets
1. Wheelchair Accessible Base Cabinet without doors.

X. Accessories:

1. Digital Face Velocity Alarm System):
Kewaunee Air Alert (Option A1 or A2)
Fume hoods shall be provided with an alarm system to detect low and high hood face velocities. The alarm system shall indicate the actual face velocity of the hood regardless of sash position. The system shall have an air velocity sensor mounted on the interior side liner of the hood where it is easily accessible for cleaning. The velocity monitor shall digitally display the air velocity through the hood face in feet per minute. The alarm signals shall activate any time the face velocity falls below the low velocity alarm set point. There shall be both visual and audible alarm signals. The audible alarm shall have a mute. Low and

high alarm contacts shall be provided for remote monitoring. An hour-long "event timeline" detailing low velocity episodes shall be part of the alarm readout.

2. Auto Sash return to 18" (Option R1):
   The Auto sash return option provides an automatic gravity operated sash return that lowers the sash to 18" from the full-open setup position. When the sash is raised to the full open position, a sash lock holds the sash open for setup purposes. By pressing the electronic sash stop release button, the sash automatically closes to the 18" operating height.

3. Fire Suppression System (Option E):
   Fire suppression system must utilize CFF 800 Dual Agent ABC Dry Chemical Fire Suppression System Unit, vertically mounted in the top of the fume hood for complete coverage. The suppression unit is to be fully self-contained and easily removed for maintenance or replacement.
   Each fire suppression unit is to be equipped with:
   - Pressure gauge for easy status checking
   - A pressure switch that can be wired back to a monitoring or control panel (IE; burglar alarm) for 24-hour a day monitoring supervision and notification
   - a 155^{o}F temperature bulb for automatic heat activation

   To ensure complete coverage, four foot, five foot, six foot and eight foot long fume hoods are protected with one fire suppression unit mounted in the center of the enclosure. Ten foot and twelve foot long fume hoods require two units for complete protection.

4. Work Shelf Supports (Option W):
   Fume hoods to be fitted with a removable work shelf cleats used to mount a work shelf at 36" above the floor. Fume hood to include reinforcements in the fume end walls used to attach the work shelf cleats and to carry the weight of the Work Shelf.

5. Ceiling Enclosure:
   Fume hood to be fitted with a steel enclosure to fill the space between the top of the hood and the ceiling. Enclosure is to be three sided and designed and manufactured to provide a finished appearance. Front panel of enclosure is to be removable.

6. Finished back:
   When a hood is located in any area where the rear of the hood is exposed to view the hood is to be fitted with a steel enclosure to finish the back of the fume hood. Enclosure to be removable without the use of tools and to be constructed in two pieces to allow safe handling.

7. Distillation Rack:
   Fume hood to be fitted with a lattice-style distillation rack consisting of vertical and horizontal ½" diameter rods. They shall be fastened with rod clamps to form a lattice of 12" squares and made out of Stainless Steel, Duralumin or Fiberglass Reinforced (FRP) rods.

Y. Fume Hood Finish:
   After the component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine-grained crystalline phosphate surface that shall provide both an

excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.

After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.

The completed finish in standard colors shall meet the performance test requirements specified under Section 2.02 A. Steel Paint Finish Performance Test Results.

2.02 PERFORMANCE REQUIREMENTS

A. Steel Paint Finish Performance Test Results (Chemical Spot Tests):

1. Testing Procedure:
   Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

2. Test Evaluation:
   Evaluation shall be based on the following rating system.
   - Level 0 – No detectable change.
   - Level 1 – Slight change in color or gloss.
   - Level 2 – Slight surface etching or severe staining.
   - Level 3 – Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

   After testing, panel shall show no more than three (3) Level 3 conditions.

3. Test Reagents:

Test No.	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Acid Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle
7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle

12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Acid	Cotton ball & bottle
16.	Dimethylformanide	Cotton ball & bottle
17.	Dioxane	Cotton ball & bottle
18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Acid, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrofluoric Acid, 48%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Cloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Acid, 20%	Watch glass
32.	Nitric Acid, 30%	Watch glass
33.	Nitric Acid, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Acid, 85%	Watch glass
36.	Silver Nitrate, Saturated	Watch glass
37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Acid, 33%	Watch glass
43.	Sulfuric Acid, 77%	Watch glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle
47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Watch glass

* Where concentrations are indicated, percentages are by weight.

4. Performance Test Results (Heat Resistance):
   Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

5. Performance Test Results (Impact Resistance):
   A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall

be no evidence of cracks or checks in the finish due to impact upon close examination.

6. Performance Test Results (Bending Test):
   An 18-gauge steel strip, finished as specified, when bent 180° over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.

7. Performance Test Results (Adhesion):
   Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197-68, "Standard Method of Test for Adhesion of Organic Coatings".

8. Performance Test Results (Hardness):
   The test sample shall have a hardness of 4-H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8-H is the hardest, and next in order of diminishing hardness are 7-H, 6-H, 5-H, 4-H, 3-H, 2-H, F, HB, B (soft), 2-B, 3-B, 4-B, 5-B (which is the softest).

   The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel-like manner until one is found that will cut or scratch the film. The pencil used before that one-that is, the hardest pencil that will not rupture the film is then used to express or designate the hardness.

B. Fume Hood Liner Performance:
   1. Chemical Spot Tests - 24 Hours:
      Chemical spot test shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

   2. Legend / Ratings:

1 - Glass Reinforced Polyester	A = No effect or slight change in gloss
2 - Stainless Steel 304	B = Slight change in gloss or color
3 - Stainless Steel 316	C = Slight etching or severe staining
4 - Reinforced Phenolic Resin	D = Swelling, pitting, or severe etching

   3. RESULTS: 1 2 3 4

1. Acetic Acid 98%	C	B	B	A
2. Acetone **	A	A	A	A
3. Acid Dichromate	B	A	A	A
4. Ammonium Hydroxide ** 28%	A	B	B	A
5. Amyl Acetate **	A	A	A	A
6. Benzene **	A	A	A	A
7. Butyl Alcohol **	A	A	A	A
8. Carbon Tetrachloride **	B	A	A	A
9. Chloroform **	B	A	A	A
10. Chromic Acid 60%	C	C	C	A
11. Cresol	A	A	A	A
12. Dichloroacetic Acid	A	B	A	A
13. Dimethylformamide	A	A	A	A
14. Dioxane **	A	A	A	A
15. Ethyl Acetate **	A	A	A	A
16. Ethyl Ether **	A	A	A	A
17. Ethyl Alcohol **	A	A	A	A
18. Formaldehyde	A	A	A	A
19. Formic Acid 90%	B	A	A	A
20. Furfural **	C	A	A	C
21. Gasoline **	A	A	A	A
22. Hydrochloric Acid 37%	A	B	B	A
23. Hydrofluoric Acid 48%	A	D	D	A
24. Hydrogen Peroxide 30%	A	A	A	A
25. Methyl Ethyl Ketone **	A	A	A	A
26. Methyl Alcohol **	A	A	A	A
27. Methylene Chloride **	B	A	A	A
28. Monochlorobenzene **	A	A	A	A
29. Naphthalene **	A	A	A	A
30. Nitric Acid 20%	A	B	A	A
31. Nitric Acid 30%	B	B	A	A
32. Nitric Acid 70%	B	B	A	A
33. Phenol ** 85%	A	A	A	A
34. Phosphoric Acid 85%	A	B	A	A
35. Silver Nitrate	C	A	A	C
36. Sodium Hydroxide 40%	A	A	A	A
37. Sodium Hydroxide 20%	A	A	A	A
38. Sodium Hydroxide 10%	A	A	A	A
39. Sodium Hydroxide Flake	A	A	A	A
40. Sodium Sulfide	A	A	A	A
41. Sulfuric Acid 77%	A	C	A	A
42. Sulfuric Acid 96%	B	C	A	C
43. Sulfuric Acid 33%	A	C	A	A
44. Tincture of Iodine	C	B	B	A
45. Toluene **	A	A	A	A
46. Trichlorethylene **	A	A	A	A
47. Xylene **	A	A	A	A
48. Zinc Chloride	A	B	A	A
49. Nitric 70%/Sulfuric Acid 77%*	B	B	A	A

* Equal parts of Nitric Acid 70% and Sulfuric Acid 77%.

** Indicates these solvents tested with cotton and jar method

PART 3 - EXECUTION

3.00 SITE EXAMINATION

A. The owner and/or his representative shall certify building conditions conducive to the installation of a finished goods product, including all critical dimensions.

3.01 INSTALLATION

A. Preparation:
Prior to beginning installation of fume hood, check and verify that no irregularities exist that would affect quality of execution of work specified.

B. Coordination:
Coordinate the work of the Section with the schedule and other requirements of other work being performed in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

C. Performance:
Install fume hoods, plumb, level, rigid, securely anchored to building and adjacent furniture in proper location, in accordance with manufacturer's instructions and the approved shop drawings. Provide filler panels between top of hood and ceiling. Securely attach access panels but provide for easy removal and secure reattachment. Do not install any damaged units.

D. Adjust and Clean:
1. After installations are complete, adjust all moving parts for smooth operation.
2. Remove all packing materials and debris resulting from this work and turn over the fume hoods to the owner after cleaning and polishing both inside and out.
3. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.

E. Protection:
1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
2. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

F. Certification:
1. Fume Hood Manufacturer shall field test a random sample of 20% of the installed units using ANSI/ASHRAE 110-2016 to a control level of Al 0.1 ppm or better (Per ANSI Z-.5-2012).
2. Project substantial completion shall be withheld until all required fume hood certification letters, tests, and reports have been submitted to and approved by the Architect.

[END]

SECTION 11 5350 LABORATORY EQUIPMENT- ENVIRONMENTAL CHAMBERS

Part 1- GENERAL REQUIREMENTS

1.01 SUMMARY

A. Section Includes:

1. Providing all labor, materials, equipment, and services necessary for the complete installation of environmental insectary rooms in accordance with the Contract Documents.
2. Factory assembly and testing of major components, including conditioning module, compressor/condensing unit, humidification/dehumidification equipment, and control panels.
3. Delivery of room components to their final location, and assembly of rooms in place by factory trained technicians.
4. Refrigeration piping, electrical power wiring, control wiring to equipment and devices which are an integral part of the rooms. Final connections coordinated with contractor, including interconnection to building mechanical, plumbing and electrical services.
5. Startup and field testing of rooms by factory trained technical personnel.

1.02 SYSTEM DESCRIPTION

A. Design Requirements

1. Environmental chambers shall be designed, manufactured, and installed by one supplier for single source responsibility.
2. Rooms shall be self-contained units with all essential systems and equipment necessary for a complete and functional room.
3. Design systems with sufficient capacity to simultaneously and continuously meet all loads, including heat transmission from external sources, ventilation load, and internal heat gain from equipment, and lighting. Provide any additional power, in excess of the amount scheduled, that is required to maintain specified environmental conditions.
4. The environmental room design and installation shall conform to applicable codes, ordinances, and regulations.

B. Performance Requirements

1. Achieve the environmental room temperature and humidity conditions scheduled on the Drawings and maintain the conditions within the specified tolerances.

1.03 SUBMITTALS

A. Manufacturer's Data: Submit, for approval, manufacturer's data for all growth rooms components including room structural panels, conditioning modules, compressor / condensing units, humidification / dehumidification equipment, control panels and lighting fixtures.

B. Shop Drawings: Submit shop drawings, minimum scale 1/4 inch = 1’-0” which include dimensioned plans, elevations, and sections. Provide utility data, details, and other information required for proper evaluation of work and for coordination with other related work.

C. Submittal shall include calculations for cooling, heating, and dehumidification loads and required equipment capacities, provide refrigeration piping schematic showing all components and their respective size or capacity, airflow schematic, and written sequence of operation for the refrigeration system.

D. Submittal shall show all power connections to lighting and equipment, the voltage, amperage,

and kW load for each circuit.

E. Provide roughing in requirements for mechanical and electrical services.

F. Test Reports: Submit reports of all specified factory and field performance tests.

G. Operating and Maintenance Manuals: Before request for final payment, provide Operating and Maintenance Manuals that reflect as-built conditions and provide detailed operating and maintenance procedures.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Environmental insectary rooms and associated equipment shall be provided by a single laboratory growth room manufacturer.

B. Manufacturer's Qualifications:
   1. 10 years or more experience in manufacture of growth rooms and equipment of types specified.
   2. 10 installations of equal or larger size and with specified product designs. Wall mounted air handling unit, drawing air in near floor level, conditioning and discharged vertically downward through duct socks.

C. Installer’s Qualifications: Technicians factory trained and experienced in the architectural, mechanical and electrical skills necessary to assemble and put the growth rooms into operation.

1.05 DELIVERY, STORAGE AND HANDLING

A. Schedule delivery of equipment when building spaces are sufficiently complete so that material can be installed immediately following delivery.

B. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating.

1.06 PROJECT CONDITIONS

A. Do not deliver or install equipment until windows and doors are installed and the building is secure and weathertight.

B. Examine project conditions at the site with regard to access, dimensions and the general areas of work. Installation work shall be performed in close coordination with other trades.

C. Provide for any mechanical or electrical service different than that shown on the construction Drawings or indicated in these Specifications, necessary to accommodate the manufacturer's product requirements.

1.07 **WARRANTY**

A. Provide a written warranty stating the product is free from defects in material or workmanship under normal use and service. Warranty shall become effective following the acceptance date and cover the following items for the noted duration:
   1. 10 year insulated panel warranty.
   2. 5 year compressor warranty.
   3. 2 year parts warranty.
   4. 2 year labor warranty

PART 2- PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design (Product Standard): Contract documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
    a. Basis of Design: Conviron

2.02 ROOM CONSTRUCTION

A. Rooms shall be of modular construction incorporating wall, ceiling and floor panels consisting of foamed-in-place polyurethane insulation sandwiched between interior and exterior metal surfaces. Provide panels in standard size increments, fully interchangeable, and in a configuration that meets the specified dimensions. Structural metal, wood, or fiberglass materials shall not be used between interior and exterior surfaces.

B. Insulation: Foamed-in-place non-CFC polyurethane 4.25 inch thick panels.

C. Assembly: Panel sections shall lock together from inside the room with non-corrosive cam type fasteners, providing accurate, tight joining. Provide a minimum of 3 locking devices on each vertical joint. Distance between locking devices shall not exceed 48 inches. Edge of panels shall be tongue and groove construction with every tongue including an interior and exterior flexible vinyl gasket to ensure a tight fit. Batten strips or pressure clips as a means of covering seams or joining panel sections shall not be utilized. Close wrench holes with flush mounted plastic or stainless steel caps.

D. Wall and Ceiling Panels:
    1. Thickness: 4.25 inches
    2. Exterior Finish: White enamel baked on stucco 26ga. galvanized steel.
    3. Interior Finish: White enamel baked on smooth 24ga. galvanized steel.
    4. Reinforce wall panels to support wall mounted shelving if applicable.

E. Floor:
    1. Provide rooms without floors. Seal wall panels to floor with continuous caulking bead.
    2. Epoxy Flooring: provided by others

F. Doors:
    1. In fitting, semi flush, with a minimum clear opening of 36 inches wide by 78 inches high. with inside safety release latch and cam-type self-closing hinges. Door has positive closer device, thermal plastic gasket with magnetic core, and door stop.
    2. Observation Window: Minimum of 14 inches by 14 inches, minimum dual pane, light tight cover.
    3. Lock: Provide with keyed cylinder lock capable of release from the room interior whether or not the door is locked.

G. Closure Panels: Furnish and install vertical and horizontal closure panels, strips and shrouds to close opening between growth rooms and adjacent building partitions and ceiling. Finish to match adjoining growth room wall panels. Provide sealant to prevent any escaped insects from breaching the closure panels.

2.03 INTERIORS

A. Conditioning Module:
    1. Room air shall be temperature conditioned by a conditioning module consisting of multiple evaporator coils with drain pan, air circulating blowers and controls.
    2. Mount conditioning coils within room wall designs. Conditioning module shall draw air from bottom of wall and expel in a falling manner at top of the plenum Clear height

within either style of room shall be a minimum of 95” AFF.

3. Electrical power feed to conditioning module shall be through the growth room control panel.

B. Lighting:

1. Visibility lighting using sealed LED fixtures.
2. Fixtures shall provide 4000k color temperature.
3. Control: Exterior light switch shall be mounted adjacent to door.

2.04 REFRIGERATION SYSTEM

A. Design:

1. Complete integrated system consisting of a conditioning module, compressor/condenser unit, interconnecting piping, interconnecting wiring, and controls designed for continuous system operation. The refrigeration system shall be a fully modulating type which continuously proportions the mixture of liquid and hot gas phases of the refrigerant entering the evaporator, utilizing a modulating control valve. On/off solenoid valve type of control will not be acceptable. The system shall also include high/low pressure controls, receiver, expansion valve, and all the necessary components for a complete system to achieve the specified performance.
2. System capacity shall be sufficient to simultaneously and continuously meet all loads, from 0 to 100 percent, including heat transmission from external sources, ventilation load and internal heat gain from equipment, lighting and people.
3. All major refrigeration components including condenser, compressor, receiver, suction accumulator, control and pressure regulating values and electrical disconnect shall be placed in a discrete outdoor air-cooled condensing unit manner, including weatherized hood and crankcase heater for low ambient conditions suitable for use at project site location using current Ashrae design standards.
4. Refrigerant: Condensing using shall use CFC-free refrigerant (R-448A or R-449A). R-134A and R-404A refrigerants shall not be used.
5. Refrigeration coils shall be phenolic coated.

B. Conditioning Module:

1. Conditioning unit shall contain all fans, heaters, and valves necessary to meet the specified parameters.
2. Wall mounted air handling unit shall contain all fans, coils and air handling equipment. Air flow is circulated continuously by drawing into conditioning unit near floor level, conditioned and discharged vertically downward through duct socks.
2. Air in the room is re-circulated continuously by conditioning unit.

C. Compressor/Condenser Unit:

1. Use remote outdoor air-cooled condensing units incorporating scroll-type compressor sized to maintain temperature / humidity conditions scheduled for each room on the drawings.
2. Manufacturer: Copeland Corporation; Sidney, Ohio, or equal.
3. All components of the unit shall be designed for 125 psig working pressure or 150 percent of maximum operating pressure, whichever is greater.
4. Refrigeration system operation shall be monitored by room control system, including visual and audible alarms. System shall include pressure transducers to allow for real-time diagnostics for preventative maintenance and repair.
5. Unit shall be designed for continuous operation for maximum compressor life and to eliminate on-and-off cycling.
6. The compressor / condenser unit shall be linked to an evaporator of matching capacity.

D. Insulation: Suction and hot gas refrigeration lines shall be insulated with a closed cell foam plastic insulation. The material shall be tubular in form and sized according to the pipe size. Joints shall be thoroughly bonded by the adhesive recommended by the manufacturer of the insulation. Insulation shall meet local and state fire and smoke requirements. Penetrations of the insulation must be thoroughly sealed to form a complete vapor barrier. Wherever the insulation terminates the edges shall be sealed to the pipe with sealant.
   1. Piping line penetrations shall be the responsibility of the owner/contractor.

2.05 HUMIDIFICATION

A. Provide a humidification system to maintain temperature/humidity conditions, as scheduled on the drawings.
B. Humidification systems shall incorporate air-assisted spray nozzle methodology. Steam heating or similar is not acceptable.
C. The unit shall be complete and ready for hookup to a source of purified water and compressed air.
D. Humidity system shall include dry humidity sensor mounted in portable aspirator.
E. Provide all interconnecting wiring and controls.

2.06 HEATING COILS

A. Heaters: Heat exchanger coil(s) shall be of copper-tube construction.
B. Provide electronic control interlock to prevent heaters being energized anytime airflow is inadequate. Provide separate, independent solid state high limit control which is UL listed (UL 991) as a temperature limit device. This limit control shall monitor air temperature in the conditioning plenum, opening the heater power contactor and enabling audio and visual indicators if temperature exceeds a preset limit. The preset, nonadjustable limit setpoint shall not exceed 65 degrees Celsius, but shall be high enough to prevent false alarming under normal system operation. The tripped limit control shall require manual resetting by operation of a panel mounted push button.
C. Provide all required power and control wiring from the room main control panel to the heating coil.

2.07 VENTILATIONS SYSTEM

A. Provide a (minimum) 4 inch (100 mm) diameter exhaust duct collar on roof of the growth chamber with ventilation rate-limitation device.
B. Provide fresh air intake of 50cfm.

2.08 CONTROLS

A. Locate all instruments and controls in a control panel on the outside of the room, mounted at eye level. Chambers shall incorporate a color display HMI. Provide panel with cover and a lock with two keys. Provide cover to extend from top of control panel to above architectural ceiling to conceal conduits and wiring feeding the control panel. Provide dry contacts to allow connection to Building Management System.
B. Main Temperature Control: Microprocessor based PID controller designed for growth room applications with the following features:
   1. The microprocessor PID controller shall continuously monitor room condition versus setpoint, providing an output which will modify the conditioning system capacity in response to any deviation.

2. Controller range shall be established to cover the required range of the room as scheduled.

C. Main Relative Humidity Control: Microprocessor based controller designed for environmental room applications with the following features:
   1. The microprocessor PID controller shall continuously monitor room condition versus setpoint, providing an output which will modify the conditioning system capacity in response to any deviation.
   2. Controller range shall be established to cover the required range of the room as scheduled.

D. High Temperature Safety Control: Provide a separate and independent safety control circuit and devices installed in the control panel. This control shall be a sensitive electronic controller with setpoint dial calibrated in degrees Celsius. In the event of a high temperature alarm condition, the safety control will de-energize the heaters and lights in the room and activate an audible and visual alarm. When temperature returns to the normal range the heaters, lights, and alarm system shall automatically reset. Provide dry contact for connection to external alarm.

E. Low Temperature Safety Control: Provide a separate and independent safety control circuit and devices installed in the control panel. Its sole function shall be to deactivate the refrigeration system and activate audible and visual alarms in the event of a low temperature alarm condition. This control shall be a sensitive electronic controller with setpoint dial calibrated in degrees Celsius. When temperature returns to the normal range the alarm system shall automatically reset. Provide dry contact for connection to external alarm.

F. Data Logging and Graphing: Controller shall capture up to seven chamber variables, including aspects such as temperature, light, humidity, and C02, logged automatically every 30 seconds and displayed on trend graphs on demand. Trend graphs shall provide up to five days of history. Trend data shall also be capable of being downloaded through a USB port located at the controller location.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Deliver to job site, uncrate, and assemble all equipment specified herein. All debris and crating materials shall be removed. Components shall not be exposed to weather.

B. Sections shall match without distortion. Door shall close and seal without binding.

C. Electrical:

1. Furnishing, installation and connection of control panel, complete with disconnects for incoming service and branch circuits.

Provide a dry contact, for use by building automation system, which will close when any of the operating controls fail or when any of the safety devices prevent operation of conditioning equipment.

3. Interlocking control wiring between control panel and compressor/condenser units, conditioning module, dehumidifiers, humidifiers and heaters.

4. Provide a dry contact, for use by building automation system, which will close when ay of the operating controls fail or when any of the safety devices prevent operation of conditioning equipment.

5. Provide seal-off fitting to seal conduit and prevent condensation at all penetrations of growth room wall or roof panels.

6. Provide packaged compressor units complete with disconnects and motor starters.

D. Mechanical:

1. Service line penetrations into rooms shall be properly sealed with silicone caulking.

E. Provide carpentry supervisor and mechanical supervisor on job site whenever growth room installation in that area of work on room is taking place.

F. Manufacturer's Representative shall instruct Owner's staff in the operation of room including controls, after completion of room startup. The operating and maintenance manual shall indicate
sequential operation, startup and shutdown, with all pertinent control data and schematics.

3.02 TESTING

A. Provide all equipment and instrumentation for testing and perform tests to prove operation at the specified conditions.

B. Provide written reports, in duplicate, of all tests. Reports shall indicate procedures followed,
instruments used, and tabulation of results.

C. Temperature Range: Measure temperature using the environmental room's temperature recorder during a continuous 24-hour test period.

D. Recovery Test: All rooms shall recover preset operating temperature within 5 minutes after door has been fully opened to 75 degrees Fahrenheit ambient for a period of 1 full minute.

E. Internal Load Test: Each room shall maintain plus or minus 1.0 degree Celsius control when
operating with the amount of make-up air, and internal heat gain of lighting as shown on the schedule.

F. Witnessing of Tests: Architect shall be given the option of witnessing and confirming test results. Notify Architect, in writing,10 days prior to tests.

END OF SECTION

SECTION 11 5380
LABORATORY EQUIPMENT- DRY HEAT STERILIZERS

PART 1- GENERAL REQUIREMENTS

1.01 SECTION INCLUDES
- A. Installation of Contractor Furnished and Installed large laboratory equipment.

1.02 RELATED REQUIREMENTS
- A. Section 01 3000 Submittals
- B. Section 11 5300 Laboratory Equipment
- C. Section 11 5350 Laboratory Equipment- Environmental Chambers

1.03 WARRANTY

At a minimum, a comprehensive two year parts and labor warranty shall be included. The date of the warranty shall start at the date of substantial completion of the project.

1.04 MAINTENANCE AND OPERATING DOCUMENTS

Seller shall supply 1 set of operational and maintenance manuals on thumb-drive. It will be complete with lubrication specifications, routine maintenance, parts lists, wiring, and mechanical drawings.

1.05 UTILITIES:
- A. V: 480V/240 or 208V / 3Ø / 60Hz / 95 FLA
- B. CA: 2-5 CFM, 80-120psig
- C. EXH: 10” OD, minimal SCFM during the cycle, 580 SCFM during cooling. Up to 300°F

1.06 QUALIFICATIONS

A. MANUFACTURER’S QUALIFICATIONS

Vendor shall have been in the business of providing NFPA 86 rated dry heat sterilizers, dry heat sterilizers and related equipment for at least 10 years. In addition, vendor shall have direct laboratory animal industry experience with more than 6 years’ experience and more than six (6) successful dry heat sterilizer installations specifically in cage sterilization applications in vivariums. All bidders must provide a list of at least 5 successful installations completed in the last five years. Manufacturers shall have established organizations and production facilities including all tools, equipment and special machinery necessary for specializing in the fabrication and installation of dry heat sterilizers, with skilled personnel, factory trained workmen and an experienced engineering department.

B. INSTALLER QUALIFICATIONS

C. Installer of dry heat sterilizers shall have an established organization including all tools, equipment and special machinery necessary for specializing in the installation, start up and validation of this equipment. Personnel shall have the demonstrated knowledge, ability and the capability to install the specified equipment of the required quality and capacity to complete an installation of this size and type within the required time limits.

The firm specializing in installation of products specified shall have a minimum five years' experience and authorized by manufacturer to install product.

D. Manufacturer to provide installation standard operating procedure (SOP) documents for review along with the approval drawings. SOP's for the installation and validation to be included are, at a minimum, sterilizer field commissioning testing SOP, chamber uniformity testing SOP and cycle validation SOP.

E. Upon request, installer shall provide five references of similar installations.

1.07 MANUFACTURER

A. Products which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All dry heat sterilizers specified in this section shall be provided by a single manufacturer. Note: Edit list of manufacturers as is appropriate for project and bring the manufacturer of your chosen equipment to the top of the list.

1. Gruenberg, a brand of Thermal Product Solutions, P.O. Box 150, White Deer, PA 17887 Tel: 570 538-7200.
2. Prior approved equal

PART 2- PRODUCT INFORMATION

2.01 DRY HEAT STERILIZER CHARACTERISTICS

A. Unit shall be a truck-in style, dry heat sterilizer to be used in the sterilization of mouse, rat, or other rodent cages, bottle baskets and empty bottles, ventilated racks and various enrichment items design to be sterilized at 140°C or better.

1. NFPA RATED

Proposed sterilizer shall be rated as a NFPA 86 Class "B" dry heat sterilizer.

2.02 EQUIPMENT DESCRIPTION

A. The dry heat sterilizer shall be designed to accommodate up to 2 carts that are 26" W x 42"D x 72"H

1. INTERIOR DIMENSIONS

At a minimum, the interior chamber of the sterilizer shall be a minimum of 40"W x 90"L x 84"H.

2. EXTERIOR EQUIPMENT DIMENSIONS

The exterior dimensions of the dry heat sterilizer shall not exceed 91"W x 114"L x 145"H

2.03 DRY HEAT STERILIZER CONSTRUCTION

A. CHAMBER CONSTRUCTION

The dry heat sterilizer shall be constructed in modules, sized for ease of rigging and assembly without modification of the existing facility, from a welded heavy-duty steel frame that supports the interior stainless steel chamber. The exterior shall be constructed from stainless steel sheet metal. All interconnecting struts shall be non-continuous from inner to outer walls, thus keeping the exterior as cool as possible. A full 4" of insulation shall surround the work chamber on all sides, with the exception of the floor, which shall be a 3/16" plate floor. Locating pins integral to the frame must be used to align the

modules during assembly and have interior flanges to bolt them together for perfectly aligned seams.

B. CHAMBER SIDE RAILS

Internal side rails shall be supplied and located down the length of the work chamber. These side rails will be located at a height of 36" up from the chamber floor. The internal side rails will prevent the trucks from coming in contact with the side air duct walls in each work chamber. Chamber rail construction shall be designed for ease of cleaning and toolless removal.

C. FULLY WELDED LINER (BACK SIDE, SQUARE CORNERS)

The interior of the sterilizer shall be fabricated with 304L stainless steel with a 2B finish. All welds shall be ground and polished to match this finish. The dry heat sterilizer's stainless steel liner shall be continuously welded thus creating an impervious barrier between the process chamber and the insulation material and preventing any contamination from entering the chamber from that source.

D. FLOOR

The dry heat sterilizer shall contain a 3/16" thick plate floor. The front edges of the plate shall be beveled to give a loading truck a smooth transition into and out of the dry heat sterilizer. The facility floor shall be rated withstand to the operating temperature.

E. EXTERIOR FINISH

The exterior of the sterilizer shall be fabricated with 304 stainless steel with a #4 finish. All welds shall be ground and polished to match this finish. The following components shall be a 2B finish with welds chemically passivated: filter boxes, junction boxes, motor/blower mounts and pneumatic boxes.
The following components shall be a mill finish with welds mechanically passivated: exterior tubular stands and interior tubular guide rails.

F. DOORS

Two individual doors, one on the load end and one on the unload end, shall be fitted to the unit. The doors close against the dry heat sterilizer cabinet over a silicone "P" gasket. Each door shall be held closed by a dual cam-action bar latch and hung with a pair of stainless steel machined adjustable hinges. Each bar latch shall be supplied with an inside release handle. The bottom bar latch shall be side latching so no truck obstructions are located on the plate floor.

G. DOOR SWITCHES

A door switch shall be installed on the dry heat sterilizer to de-energize the heating and circulation systems when the dry heat sterilizer doors are opened. This is to minimize hot air from being expelled from the dry heat sterilizer should the doors be opened during the heating cycle.

H. PNEUMATIC DOOR LOCKS (PASS-THORUGH)

Each end door will be equipped with an automatic lock that will function in accordance with operational modes. Pneumatic interlocks will control the door lock sequence in this manner:

(1) When the unload door is open, the load side door is locked;
(2) When the curing cycle is engaged, both doors are locked;
(3) When the load door is open, the unload door is locked. The unload door is automatically unlocked after the completion of the cool-down cycle.

In the event of an electrical failure, both doors shall unlock. A double acting, two-port cylinder shall engage both load/unload door interlocks so that no working air shall be exhausted into the classified area. In the event of an air pressure loss, the lock shall hold its position. The interlocks shall be enclosed in housings located over the doors.

I. INTERIOR DOOR LOCK OVERRIDE

Inside the sterilizer, located along a duct wall in the work chamber, shall be door lock over-ride cables. When pulled, the cable will activate the interior door override. This will shut down the sterilizer and unlock the doors. The Safety Reset Button must be pushed to reset the PLC logic. Junction boxes to be mounted on the top of the unit.

WINDOW, DOOR

A viewing window will be mounted in the face of each door. Each viewing area will be approximately 10" wide x 15.50" high with a 6-pane glass window. Each window will be supplied with a window guard located above and below to protect the windows from accidental contact.

J. VERMIN SEAL ON UNLOAD END OF STERILIZER

Trim panels of 18 ga stainless steel matched to the exterior of the sterilizer shall be fitted to cover the area between the wall opening and the unit so that a flush appearance is achieved. The trim panels are held in place by magnets on the back of the panel to simplify the installation. This will provide an impassable barrier to rodents on the bottom and sides of the unit. After installation of vermin seal panels, the panels are to be caulked and sealed airtight.

K. MODULAR/SPLIT CONSTRUCTION

The unit will be built in modular sections to accommodate move in restrictions. The joining flanges shall be interior flange design. No joining hardware is to be mounted on the outside of the unit. Sections will contain tapered alignment pins for ease of reassembly where possible. The unit pieces shall be sized so that no construction, removal of doors or similar is required to get them into the facility

2.04 PROCESS AIR CIRCULATION

To ensure uniform heat distribution throughout the dry heat sterilizer chamber and optimize efficiency, a high volume, horizontal airflow system is installed in the unit. Two (2) direct driven circulation blowers, located in a plenum chamber on the top of the sterilizer, direct air to a circulation duct down one side of the dry heat sterilizer. The air enters the work space through a perforated wall, flows horizontally across the product, and exits the work space through a perforated wall on the other side, the air is then directed back to the blower for reheating and recirculation.

The output of the circulation motor(s) will be controlled by a Variable Frequency Drive to allow for optimization of the uniformity tuning of the dry heat sterilizer system.

2.05 AIR HEATING SYSTEM

Seamless-tubular incoloy type heaters shall be used as the heat source. The heaters are suspended in the plenum, adjacent to, but separate from the process chamber, so that work in progress and operators are protected. Terminal ends are inserted through the walls of the dry heat sterilizer and use sufficient dead zones so that heat is not generated beyond the plenum. All heaters are wired with double nut connections. The heaters shall be positioned between the circ. return duct and the circ. fan to ensure the maximum utilization of the electric heaters and the re-circulation of conditioned air.

2.06 FILTRATION

A. INTAKE AIR PRE-FILTER
Air shall be pre-filtered through a 25-40% roughing filter, 18” x 18” x 2” thick

B. EXHAUST AIR PRE-FILTER
Air shall be pre-filtered through a 25-40% roughing filter, 18” x 18” x 2” thick

C. AIR INTAKE HEPA FILTER
A 18” x 18” x 5-7/8” HEPA filter, rated at 99.97% efficient at particles 0.3 microns or larger, shall be installed in a stainless steel housing on the incoming airflow side of the conditioning path. Challenge ports are provided for the verification of filter integrity. Access panels in the filter housing are secured with acorn nuts on 3” centers.

D. AIR EXHAUST HEPA FILTER
A 18” x 18” x 5-7/8” HEPA filter, rated at 99.97% efficient at particles 0.3 microns or larger, shall be fitted to the exhaust path to protect the chamber from particulate backflow. Challenge ports are provided for the verification of filter integrity. Access panels in the filter housing are secured with acorn nuts on 3” centers.

E. FORCED EXHAUST SYSTEM
A 580 SCFM exhaust blower that will operate at 60-80 SCFM during the sterilization phase and 580 SCFM during the cooling phase shall be installed to the dry heat sterilizer’s air exhaust system and be initiated by an output from the programmable temperature controller to provide for moisture removal during the sterilization period, and a cooling capacity at the end of the temperature soak cycle. The blower will be 2-speed, with a lower rpm during the ramp and soak period and a higher speed during the cooling period. A 10” O.D. exhaust collar will be supplied for attaching customer’s exhaust connection.

2.07 CONTROLS AND INSTRUMENTATION

A. CONTROL CONSOLE, (Located at Load End)
All operating controls for the dry heat sterilizer shall be housed in a single NEMA 12 control console. Circuit wiring is complete, including a step-down transformer to provide the control circuits with 110 volt power. Wiring in the panel terminates in a suitable block for connection to the customer’s power supply. Interconnect wiring will be the responsibility of others.

B. CONTROL BOX, (Located at Un-Load End)
A smaller unload side control box shall be located on the un-load end of the unit. This control box will be NEMA 12 construction and shall house a 10” color touchscreen controller. The control box shall be a wall mount design and remote mounted. Interconnect wiring by others.

C. U.L. LABELED
Both the control console and the control box shall be designed and built to comply with all current and pertinent UL508A directives and labelled. All control boxes will be rated at NEMA 1, built to NEMA 12 design.

D. E-STOPS
Both the control console and the unload end control box shall include E-Stops. When pressed, the sterilizer heat, circulation and exhaust fans shall stop and the load end doors shall unlock.

E. CONTROLS PROTECTION RAIL
Stand-off rails shall be included on the face of the control console and HMI box to protect the face of the electrical controls from accidental damage from being hit by carts and operators. The bumper rails shall be a round design without sharp edges for easy cleaning and located above and below the controls on the face of the console.

F. PASS THRU CONTROL OPERATION
The unit will be programmed with the ability for operation to include: Loading and Unloading orientations: A to B, B to A, B to B, or A to A. This feature will include the ability to select a desired recipe that will correspond with the loading orientations.

2.08 DISCONNECT SWITCH
A fused power disconnect switch shall be installed on the main control console for safe maintenance of the sterilizer. The disconnect switch assures that the panel power is de-energized before the access door can be opened.

2.09 OPERATOR INTERFACE TERMINALS, 10” Displays
Two Operator interface terminals shall be supplied with this unit. One located in the load end main control console and one in the unload end control box. At a minimum, these shall feature:

1. 10 inch diagonal (800 x 480) color TFT LCD and an analog-resistive touchscreen
   Serial, Ethernet communications, and USB
   - Expandable memory for recipe and data log storage
   - Support monitoring from a personal computer (PC) with free VNC Client software
   - Data logging in Excel®-compatible comma separated value (.csv) files
- Recipe management
- 128MB Memory
- Provides audible alarms and key chirp
  - Flexible 4 level password security
  - UL®, NEMA 4, CE, RoHS rated

2.10 PLC
An Allen Bradley Micro850 PLC with on board Ethernet communications must be supplied to provide all control and functional logic of the sterilizer.

2.11 HIGH LIMIT THERMOSTAT

A separate, independent high limit thermostat shall be provided to de-energize the heating system should the process temperature reach the customer's preset limit. The high limit control must be manually reset to reactivate heating.

2.12 AIRFLOW SWITCHES

Pressure differential switches shall be installed and located in the air stream of the circulation and forced exhaust systems. Upon failure of either system, the airflow switch will de-energize the heater circuit.

2.13 SEPARATE MAIN POWER RELAY

This relay is in addition to the normal relays serving the heater circuits. It shall be wired into the control circuit so that the high limit thermostat activates it. Should the main relays become mechanically frozen, as a result of extended use, this "back up" relay is deactivated, and the heat system will be de-energized.

2.14 SCR

The sterilizer shall use SCR power controls installed to proportion power to the heaters only as necessary to maintain set-point temperature. This minimizes swings in set-point temperature, provides good temperature uniformity within the chamber, conserves energy and provides longer heater life.

2.15 PANEL MOUNT THERMAL PRINTER, EVENT LOGGER

A thermal panel mount 2" printer shall be included. It shall feature easy paper loading, incorporated paper cutter, end of roll signal, USB and RS232 connections. A NEMA 4 rated enclosure shall be supplied, mounted to the face of the control console.

2.16 COMMUNICATIONS INTERFACE MODULE

A Communications Interface module may be provided on the control panel. It shall include an Ethernet Port and a 120 VAC outlet for the connection of an external PC to perform software maintenance. A USB port shall also be provided.

2.17 AUDIBLE ALARM

An audible alarm with manual silencer shall be provided. Alarms, at a minimum, will indicate over-temperature alarm, circ. and exhaust low airflow alarm, temperature deviation alarm, and filter alarm.

2.18 DRY CONTACTS FOR BMS INTEGRATION

The sterilizer shall be provided with two dry contacts. One shall signal the building management system (BMS) when the sterilizer is in cycle at low exhaust flow. The second dry contact shall signal the BMS when the sterilizer is in cooling at high exhaust flow.

2.19 LOADING TRUCKS/TROLLEYS

As an option, supplier shall quote sets of four (4) stainless steel bulk trucks that are 26" W x 42"L x 72" H. The bulk trucks shall be constructed of 1-1/4" square x 16 gauge wall tubular frame, 3/8" diameter solid vertical rods, and 1/4" diameter base and shelf rods, all of type 304 stainless steel with #4 brushed finish. All joints welded full length and ground and polished to #4 finish. Base and shelf rods shall be spaced on 2" x 2" centers. Shelf must be removable. Vertical rods

shall be spaced on 3" centers. Carts equipped with four stainless steel casters two rigid and two swivel, with 5" diameter hi-temp wheels. Casters shall be sealed and rated for operation to at least 300°. Two swivel casters equipped with step-on brakes. Up to four (4) carts can be used in the sterilizer for each cycle.

2.20 TESTING AND ACCEPTANCE

The factory testing will include at least two tests: one empty chamber uniformity mapping, and one full chamber uniformity mapping and sterilization test. (Customer may supply a full complement of trucks and cages or the seller shall include these items for testing).
Factory standard testing and standard operating procedure documents shall be provided for review along with the approval drawings. SOP's to be included are, at a minimum, sterilizer functional testing SOP, chamber uniformity testing and calibration SOP, HEPA filter testing SOP, temperature controller and high limit calibration SOP and full load testing SOP.
Testing shall be performed using calibrated NIST traceable data recording equipment. The documentation of calibration shall be submitted to the client along with the test data.

2.21 TEMPERATURE UNIFORMITY

The sterilizer shall be equipped to maintain a temperature uniformity of ± 5ºF, at a test temperature of 300ºF. Test temperature readings are taken within a volume of space not exceeding 80% of each empty work chamber or closer than 3" from any of the six interior surfaces of each work chamber. At a minimum, a 20-point uniformity test will be performed with a soak length of 60 minutes.

2.22 PRE-SHIPMENT EVALUATION WITNESS TEST

All equipment shall be built to the referenced specification and subject to the standard seller's test protocols pertinent to the specific equipment design. Additional test protocols maybe completed if agreed to prior to the equipment purchase. Clients shall be welcome to visit the factory *by arrangement* prior to shipment of their equipment in order to carry out a Pre-Shipment Evaluation Witness Test. As a minimum, this evaluation will consist of the following.

- Dimensional review and quality check of system.
- Review of completed test data.
- Controls overview and interface.
- Functional review: Cycle operated either through the equipment design extremes or through the clients agreed to cycle parameters. Cycle operation is performed with a loaded chamber, including temperature mapping of the customer's load.

PART 3- EXECUTION

3.01 INSTALLATION

Seller shall send a factory trained technician(s) to manage and supervise the rigging and installation of the dry heat sterilizer. The installation shall be performed using a local rigger, at the direction and supervision of the seller's technician.

3.02 START-UP and TRAINING

Seller shall send a factory trained test technician to perform the start-up of the sterilizer. Training on the control system, maintenance, and overall features of the unit shall be provided. The startup shall follow manufacturer's standard SOP for startup and standard agenda for the user training.

3.03 POST INSTALLATION VALIDATION

Seller shall send a trained test technician to perform a Post Installation Validation on this unit. The scope of work will consist of commissioning the sterilizer and the execution of the system's validation protocols as they were when the unit was tested at our facility before being shipped. A minimum of 3 different cycle types shall be developed and validated as part of the proposal. The installation shall follow manufacturer's SOP for cycle validation and be available for review prior to bid award. A written validation report showing the efficacy as challenged with a minimum of (20) 10-6 biological indicators for each cycle shall be provided to users at the end of testing.

3.04 INSTALLATION, START UP, TRAINING AND VALIDATION DOCUMENTATION

As part of the approval drawing process, seller shall provide copies of their standard operating procedures for the installation, start up, user training and post installation validation for review.

END OF SECTION

SECTION 122400 ROLLER WINDOW SHADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Manually operated, roll-up fabric interior window shades including mounting and operating hardware.

B. Motorized, roll-up fabric interior window shades including motor operator, controls, and mounting hardware.

1.2 RELATED SECTIONS

A. Section 06 10 00 - Rough Carpentry.

B. Section 07 90 00 - Joint Protection.

C. Section 09 21 16 - Gypsum Board Shaft Wall Assemblies.

D. Section 09 51 23 - Acoustical Tile Ceilings.

E. Division 26 - Electrical: Electrical supply, conduit, and wiring for motorized window shades.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 701-99 - Fire Tests for Flame-Resistant Textiles and Films.

C. GREENGUARD Environmental Institute Children & Schools.

D. US Green Building Council.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 33 00 - Source Quality Control Reporting:

B. Product Data: Manufacturer's data sheets on each product specified, including:
   1. Preparation instructions and recommendations.
   2. Installation and maintenance instructions.
   3. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
   4. Storage and handling requirements and recommendations.
   5. Mounting details and installation methods.
   6. Typical wiring diagrams including integration of motor controllers with building management system, audiovisual and lighting control systems as applicable.

C. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.

D. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings, field verified window dimensions, quantities, type of shade,

controls, fabric, and color, and include opening sizes and key to typical mounting details.

E. Selection Samples: For each finish product specified, two complete sets of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.

F. Verification Samples: For each finish product specified, two complete sets of shade components, unassembled, demonstrating compliance with specified requirements. Shade fabric sample and aluminum finish sample as selected, representing actual product, color, and patterns. Mark face of material to indicate interior faces.

G. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

H. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years experience in manufacturing products comparable to those specified in this section.

B. NFPA Flame-Test: Passes NFPA 701. Materials tested shall be identical to products proposed for use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver window shades until building is enclosed and construction within spaces where shades will be installed is substantially complete.

B. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.

C. Label containers and shades according to Window Shade Schedule.

D. Store products in manufacturer's unopened packaging until ready for installation.

1.7 SEQUENCING

A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.

B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.8 PROJECT CONDITIONS

A. Install roller shades after finish work and ambient temperature, humidity and ventilation conditions are maintained at levels recommended for project upon completion.

1.9 WARRANTY

A. Hardware and Shade Fabric: Draper's standard twenty-five year limited warranty.

B. Motors and Controls: Draper's standard five year limited warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Draper, Inc., which is located at: 411 S. Pearl P. O. Box 425 ; Spiceland, IN 47385-0425; Toll Free Tel: 800-238-7999; Tel: 765-987-7999;

B. Requests for substitutions will be considered when submitted in accordance with provisions of Section 01 60 00 and MUST INCLUDE a line by line compliance and comparison statement of the requirements of this Section for consideration of proposed product to specified product.

2.2 MANUALLY OPERATED WINDOW SHADES

A. Manually Operated Window Shades with Independent Control: Manually operated, vertical roll-up, fabric window shade with components necessary for complete installation; Manual Flex Shade XD as manufactured by Draper, Inc.
   1. Operation: Bead chain and clutch operating mechanism allowing shade to stop when chain is released. Designed never to need adjustment or lubrication. Provide limit stops to prevent shade from being raised or lowered too far.
      a. Clutch mechanism: Fabricated from POM thermoplastic with welded 0.354 inch (9 mm) primary steel post with rotational bearing, overrunning design, and positive mechanical engagement of drive mechanism to tube. White or Black color as selected by Architect. Center bead chain placement for right or left hand operation and accommodates side channel with no adjustment of chain location.
      b. Bead chain loop: Stainless steel bead chain.
      c. Bead Chain Hold Down: P-Clip.
   2. Rollers: Extruded aluminum roller tube of appropriate diameter to support shade fabric with minimal deflection.
      a. Minimum Roller Tube Diameter: 1.56 inches (40 mm).
      b. Fabric Connection to Roller Tube: Spline fabric/roller attachment system to allow shade fabric to be removed from roller without having to remove roller from brackets.
      c. Fabric Length: 6 inches (152 mm) greater than window height minimum.
      d. Bottom Slat: 13/16 inch (20.6 mm) aluminum dowel, encased in bottom hem with heat sealed ends.
      e. Orientation: Regular from back of roller.
   3. Mounting:
      a. End caps only.
      b. Ceiling pocket.
   4. End caps: Stamped steel with universal design suitable for mounting to ceiling, wall, and jamb. Provide size compatible with roller size.
      a. End cap covers: To match fascia or head box color.
   5. Type D Shade pocket: Rectangular pocket and end caps designed for recessed ceiling installation of window shades.
      a. Material: Extruded aluminum alloy or steel with white finish.
      b. Size: 5 inches (127 mm) wide by 5-3/8 inches (137 mm) high.

c. Closure Panel:
1) 3 inch (78 mm). If selected for CL or XD installer must notch the closure panel to allow the chain to pass through.

2.3 FABRIC

A. Light-Filtering Fabrics
1. Sheer Weave Series SW2500 by Phifer: VOC Emissions: GREENGUARD Children & Schools -certified as a low emitting fabric. Manufacturer to supply GREENGUARD Children & Schools certificate. 500 denier fiberglass, vinyl coated and woven into a 2 x 2 basket weave. Fire rating: NFPA 701. Bacterial and Fungal Resistance: ASTM G 21 and ASTM G 22. Series SW2500, 1 percent open, .024 inches thick.
2. Sheer Weave Series SW2400 by Phifer: VOC Emissions: GREENGUARD Children & Schools -certified as a low emitting fabric. Manufacturer to supply GREENGUARD Children & Schools certificate. 500 denier fiberglass, vinyl coated and woven into a 2 x 2 basket weave. Fire rating: NFPA 701. Bacterial and Fungal Resistance: ASTM G 21 and ASTM G 22. Series SW2400, 3 percent open, .019 inches thick.
3. Series SW2701 Sheer Weave: Duplex basket weave fabric-light exterior color combined with dark interior color for thermal comfort and view-through. GREENGUARD Children & Schools certified as a low emitting fabric. Manufacturer to supply GREENGUARD Children & Schools certificate. Fire rating: NFPA 701. SW2701-.1 percent open.
4. Series SW2703 Sheer Weave: Duplex basket weave fabric-light exterior color combined with dark interior color for thermal comfort and view-through. GREENGUARD Children & Schools certified as a low emitting fabric. Manufacturer to supply GREENGUARD Children & Schools certificate. Fire rating: NFPA 701. SW2703-3 percent open.
5. Color: To be selected by Owner during submittal process.

B. Room Darkening Fabrics
1. Sun Bloc Series SB9100: Close woven fiberglass base textile with sun-resistant vinyl film bonded to each side, opaque with minimum tensile strength of 190 pounds for warp and 180 pounds for fill. Fire rating: NFPA 701 1006-Test 1. Washable and stain resistant. Wt. 12 oz/sq yd. White exterior in all colors, .013 inches thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Coordinate installation of recessed shade pockets with construction of suspended acoustical panel ceilings specified in Section 09 51 13.

B. Coordinate installation of recessed shade pockets with construction of suspended gypsum board ceilings specified in Section 09 21 16.

C. Coordinate requirements for power supply conduit, and wiring required for window shade motors and controls.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install roller shades level, plumb, square, and true. Allow proper clearances for window operation hardware.

C. Shade pockets:
1. Install shade pockets prior to installation of suspended ceiling system. Attach to supporting structure with screws through top of pocket at 24 inches (610 mm) minimum centers.
2. Install shade pockets in conjunction with installation of suspended ceiling system. Attach to supporting structure with screws through top of pocket at 24 inches (610 mm) minimum centers.
3. Install corner pieces securely and in alignment with pockets.
4. Install pocket ends securely and in alignment with pockets.
5. After interior construction is essentially complete, install shade and operating mechanism in pocket.

D. Install the following items to conceal roller and operating mechanism. Do not use exposed fasteners.
1. Closure panels.

3.4 TESTING AND DEMONSTRATION

A. Test motorized window shades to verify that controls, limit switches, interface to other building systems, and other operating components are functional. Correct deficiencies.

B. Test window shades to verify that operating mechanism, fabric retainer, and other operating components are functional. Correct deficiencies.
1. Motorized operating mechanism.

C. Demonstrate operation of shades to Owner's designated representatives.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 SCHEDULES

A. Refer to Drawings for shade types and locations.

END OF SECTION - 122400

SECTION 123553 13 – STEEL LABORATORY CASEWORK AND RELATED PRODUCTS

PART 1 — DESCRIPTION OF WORK

1.00 SUMMARY AND SCOPE

A. Section Includes:

1. Basis of Design; Kewaunee Scientific Corporation, RESEARCH COLLECTION Laboratory Furniture as a steel casework specification standard, furnish all cabinets and casework, including tops, ledges, supporting structures, and miscellaneous items of equipment as listed in these specifications, equipment schedules, and drawings. Include delivery to the building, set in place, level, and scribe to walls and floors as required. Furnish and install all filler panels, knee space panels and scribes as shown on drawings.

2. Furnish and deliver all utility service outlet accessory fittings, electrical receptacles and switches as listed in these specifications, equipment schedules, and drawings, as mounted on the laboratory furniture. All plumbing and electrical fittings, not preinstalled in equipment, shall be packaged separately and properly marked for delivery to the appropriate contractor.

3. Furnish and deliver, for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment or listed in these specifications, equipment schedules, and drawings. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.

4. Furnish service strip supports where specified, and set in place, service tunnels, service turrets, supporting structures and reagent racks of the type shown on the drawings.

5. Remove of all debris, dirt and rubbish accumulated as a result of the installation of the laboratory furniture to an onsite container provided by others, leaving the premises broom clean and orderly.

B. Related Divisions:

1. Divisions 6: Behind-the-Wall Blocking and Studs
2. Division 9: Base Molding
3. Division 11: Chemical Fume Hoods
4. Division 22: Plumbing
5. Division 26: Electrical Fittings and Connections
6. Division 27: Communications

C. Related Publications:

1. SEFA 3 - Scientific Equipment and Furniture Association
2. SEFA 8 - Scientific Equipment and Furniture Association
3. NFPA 30 - National Fire Protection Association
4. NFPA-45 - National Fire Protection Association
5. UL - Underwriters Laboratories
6. ASTM D522 - Bending Test

1.01 BASIS OF DESIGN

A. Basis of Design; Kewaunee Scientific Corporation – RESEARCH COLLECTION Laboratory Furniture both ADA and Standing as the standard of construction for laboratory furniture. The construction standards of this product line shall provide the basis for quality and functional installation.

B. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval from the owner/architect. This approval must be obtained seven (7) days before the quotation deadline. Procedures for obtaining approval for an alternate manufacturer are defined in section 1.03.B in this specification.

C. General Contractors should secure a list of approved laboratory furniture manufacturers from the architect as a protection against non-conformance to these specifications.

D. Participants in the quotation process have the option of clarifying deviations to the specified design, construction, or materials. Without such clarifications, sealed quotations to the owner or owner representative will be construed as being in total conformance to the requirements of the specification.

E. The owner/owner’s representative reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

1.02 QUALITY ASSURANCE

A. The steel laboratory furniture contractor shall also provide worktops and fume hoods all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.

B. General Performance: Provide certification that furniture shall meet the performance requirements described in SEFA 8.

C. Finish Performance: Provide independent test lab certification that furniture shall meet the performance requirements described in section 2.05 of these specifications.

1.03 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's data and installation instructions for each type of casework.

B. Samples:
Samples from non-specified manufacturers will be required and reviewed per specification. Samples shall be delivered, at no cost to the architect or owner, to a destination set forth by the architect or owner. This must be done seven (7) days before quotation deadline as a condition of approval of each bidder. Samples shall be full size, production type samples. Miniature or "Show Room" type samples are not acceptable. Furnish the following:

1. One 18" combination (1) drawer and (1) cupboard base unit showing complete construction details, including (1) shelf
2. One sample of all top materials shown or called for, of sufficient size to perform finish requirement tests
3. Sample of all mechanical service fittings, locks, door pulls, hinges, and interior hardware

The architect or owner will retain the above samples of the successful manufacture to insure that material delivered to jobsite conforms in every respect to the samples submitted.

C. Shop Drawings:
Submit shop drawings for furniture assemblies showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings.

1. Coordinate shop drawings with other work involved
2. Provide roughing-in drawings for mechanical and electrical services when required

PART 2 — PRODUCTS

2.00 MANUFACTURERS

A. Manufacturers:
1. Kewaunee Scientific Corporation, 2700 Front Street, Statesville, North Carolina.
2. Avantor/VWR, One Radnor Corporate Center Building One Suite 200 100 Matsonford Road Radnor PA 19087

B. The selected manufacturer shall warrant that all products be free of defects in material and workmanship for a period of one year. The period shall start at the date of acceptance or occupation, whichever comes first. Purchaser shall notify the manufacturer’s representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

2.01 CABINET MATERIAL:

A. Steel:
Cabinet bodies, drawer bodies, shelves, drawer heads and door assemblies shall be fabricated from cold rolled steel.

2.02 DRAWER AND DOOR STYLE:

A. Overlay – Square Edge
Drawer and door, when closed, shall rest against face of cabinet shell, creating a 3/4" overlay front with 1/8" reveal. The outer drawer and door head shall have a channel formation on all four sides to eliminate sharp raw edges of steel. The top front corners of the door shall be welded and ground smooth. Cabinet shall be available with 5-knuckle, semi-concealed or concealed hinges

and optional pulls.

2.03 MATERIALS

A. General Requirements:
It is the intent of this specification to provide a high quality steel cabinet specifically designed for the laboratory environment.

B. Steel:
1. Cold Rolled Steel:
Cold rolled sheet steel shall be prime grade 12, 14, 16, 18 and 20 gauge U.S. Standard; roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches or other injurious effects.

C. Composition Core Plywood
Composition core plywood shall be 3-ply and shall be compliant with ANSI A208.1-199, and/or ANSI A208.2-1994

D. Hardware and Trim:
1. Drawer and Door Pulls: (chose one)

a. Drawer and door pulls shall be mounted on 4" centers, offering a comfortable hand grip, and be securely fastened to doors and drawers.
They shall be manufactured from: (chose one)

Pull Style 1 – Anodized aluminum in a shallow rounded shape.

2. Sliding Door Pulls:
Sliding door pulls shall be Aluminum-Recessed – Pull Style 9. Finger holes or slots machined into doors will not be acceptable.

3. Hinges: (Choose one) *(Note: not all hinges meet SEFA 8 specifications)*
a. Inset 5-Knuckle Hinges:
Inset style cabinets shall use 5-Knuckle hinges made of Type 304 stainless steel .089 thick, 2-1/2" high, with brushed satin finish, and shall be the institutional type with a five-knuckle bullet-type barrel. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted. Doors under 36" in height shall be hung on one pair of hinges, and doors over 36" in height shall be hung on three hinges. *(Note: meets SEFA 8 specifications)*
or

b. Overlay Hinges:
Overlay style cabinets shall use:
Overlay Concealed 170° Swing
Fully concealed hinges with a matte nickel finish. Hinge shall have three dimensional adjustment and provide up to 170° opening. It shall incorporate an integrated catch to keep the door closed without the use of additional catch hardware. Doors under 36" in height shall be hung on one pair of hinges, and doors over 36" in height shall be hung on

three hinges.

4. Drawer Slide:
   a. Heavy duty, full extension, soft-close, self-closing, zinc plated, ball bearing slides, rated for 100 pound loads (See Drawer Assemblies in 2.04, option 1)

5. Locks:
   a. Pin Tumbler:
      Locks when shown or called for shall be a pin tumbler with heavy duty interchangeable cylinder. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers. Locks shall have capacity of at least 2000 primary key changes, and the capacity to be Master Keyed, Grand-master Keyed, Sub-master Keyed, and Mason Keyed.

6. Catches – For steel casework with 5-knuckle hinges:
   a. Positive Catch:
      A two-piece heavy-duty cam action positive catch Main body of the catch shall be confined within an integral cabinet top or divider rail, while latching post shall be mounted on the hinge side of door. Polyethylene roller type catches are not acceptable.

7. Elbow Catches:
   Elbow catches and strike plates shall be used on left hand doors of double door cases where locks are used, and are to be burnished cast aluminum, with bright brass finish.

8. Shelf Adjustment Clips:
   Shelf adjustment clips shall be die formed, nickel-plated steel.

9. Leg Shoes:
   Leg shoes shall be a pliable, black vinyl material and shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Use of a leg shoe, which does not conceal leveling device, will not be acceptable.

10. Base Molding:
    Base molding shall be provided by others.

11. Label Holders:
    Label holders, where shown or called for, shall be self adhesive type aluminum with satin finish and designed for 2-1/2" x 1-1/8" cards, unless otherwise specified.

12. Number Plates:
    Number plates, where shown or called for, shall be self-adhesive type aluminum with indented black lettering.

13. Sink Supports:
    Sink supports shall be the hanger type, suspended from end panels of sink cabinet by four 1/4" dia. rods, threaded at bottom end and offset at top to hang from two full-depth reinforcements, welded to the top of end panels. Two 3/4" x 1-1/2" x 12 gauge channels shall be hung on the threaded rods to provide an adjustable sink cradle for supporting sinks.

14. Support Struts:
    Support struts shall consist of two 16 gauge channel uprights fastened top and bottom by two adjustable 12 gauge "U" shaped spreaders, each, 1-1/2" x length required, formed from galvanized steel. Struts shall be furnished to support drain troughs, and to support worktop at plumbing space under fume hood superstructures or other heavy loads. Support struts can be furnished with hangers at extra cost when specified, to support mechanical service piping and drain lines.

2.04 CONSTRUCTION

A. Steel Cabinet Construction:

1. General:
    a. The steel furniture shall be of modern design and shall be constructed in accordance with the best practices of the Scientific Laboratory Equipment Industry. First class quality casework shall be insured by the use of proper machinery, tools, dies, fixtures and skilled workmanship to meet the intended quality and quantity for the project.

    b. All cabinet bodies shall be flush front construction with intersection of vertical and horizontal case members, such as end panels, top rails, bottoms and vertical posts in same plane without overlap. Exterior corners shall be spot welded with heavy back up reinforcements.

    c. Each cabinet shall be complete so that units can be relocated at any subsequent time without requiring field application of finished ends or other such parts.

    d. Case openings of Inset style cabinets shall be rabbeted on all four sides for both hinged and sliding doors to provide a dust resistant case.

    e. All cabinets shall have a cleanable smooth interior. Bottoms shall be formed down on sides and back to create easily cleanable corners with no burrs or sharp edges.

    f. Cabinets shall be designed using a standardized grid pattern to allow reconfiguration of doors and drawers.

2. Steel Gauges:
    Gauges of steel used in construction of cases shall be 18 gauge, except as follows:
    a. Leveling bolt reinforcements 12 gauge.

    b. Top and intermediate front horizontal rails, apron rails, hinge reinforcements, and reinforcement gussets, 16 gauge.

    c. Drawer assemblies, door assemblies, bottom, bottom back rail, toe space rail, and adjustable shelves, 20 gauge.

B. Base Cabinets:
1. End uprights shall be formed into not less than an L formation at top, bottom, back and a 3/4"

wide front C formation. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for the support of drawer channels, intermediate rails, hinge screws, and shelf adjustment holes.

2. A 7/8" high top horizontal rail shall interlock with the flange at top of end panels for strength, but shall be flush at face of unit. Top rails not flush with face of end uprights are not acceptable.

3. Intermediate rails shall be provided between doors and drawers, but shall not be provided between drawers unless made necessary by locks in drawers. Intermediate rails shall be recessed behind doors and drawer fronts, and designed so that security panels may be added as required.

4. Intermediate vertical uprights shall be furnished to enclose cupboards when used in a unit in combination with a half width bank of drawers.

5. Cabinet bottom shall be formed of one piece of steel, except in corner units, and shall be formed down on sides and back to create a square edge transition welded to cabinet end panels. Front edge shall include a C formation to form a 7/8" high bottom front rail and shall be flush with face of end uprights. Cabinet bottom front rails not flush with face of end uprights are not acceptable.

6. Toe space rail shall extend up and forward to engage bottom panel to form a smooth surfaced fully enclosed toe space, 3" deep x 4" high.

7. Back construction shall be one piece with integral channel formed for maximum strength and welded to back of top and bottom flanges of end uprights.

8. Each bottom corner of base cabinets shall have a 3/8"-16 leveling bolt, 2-1/2" long capable of supporting 500 lbs. Access to the leveling bolts shall be through plug buttons in the cabinet bottom. Access to leveling bolts through toe space or leveling bolts requiring special tools to adjust are not acceptable.

9. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear and formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.

   Each adjustable shelf shall include a lip that extends 1/2" above the front edge.

10. Steel Door assembly (two-piece) for solid panel swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material. Door assemblies shall be painted prior to assembly, and shall be punched for attaching pulls. Inner pan formation of door shall be indented for in-field installation of

locks when required.

11. Doors shall be readily removable and hinges easily replaceable. Hinges shall be applied to the cabinet and door with screws. Welding of hinges to either cabinet or door will not be acceptable.

12. Drawer Assemblies: (Choose One)

    a. Concealed slide drawers shall be Blum LEGRABOX, with integral, concealed, full-extension, soft-close, self-closing drawer slides. Drawer bottoms shall be 5/8” composite core with brushed aluminum face.
    Concealed slide drawer sides shall be fabricated from: (Choose One)
    1) cold-rolled steel

13. Knee space panels, where shown or specified, shall be 20 gauge, finished same as casework cabinets, and easily removable for access to mechanical service areas.

C. Special Purpose Storage Cabinets:

1. Acid Storage Fume Hood Cabinets:
   Acid storage fume hood cabinets shall utilize the same gauges of steel and construction features as other base cabinets except they shall be completely lined with a one piece polyethylene corrosion resistant liner. The liner shall be 1/4" thick, molded into a seamless tub, including top, sides and bottom, with a 1" lip at the bottom front to contain spills. Tubs shall include integral cleats at both ends and back to support an optional shelf. Each door shall have a set of louvers at the top and bottom, and have a 1/8" sheet polyethylene liner. Where specified, each cabinet shall be vented into the fume hood with a 1-1/2" vent pipe allowing a positive airflow directly into the fume hood exhaust system. When specified or shown on drawings, cabinet shall include a full-depth phenolic resin.

2. Solvent Storage Cabinets:
   Solvent storage cabinets shall be specifically designed for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UFC, OSHA and NFPA No. 30 - 1993, and cabinets shall be FM approved and labeled. The bottoms, top, sides and doors shall be fabricated of 18 gauge steel and shall be all double panel construction with a 1-1/2" air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure. The doors shall swing on full-length stainless steel piano hinges and shall be fully insulated. The doors are self-closing and synchronized so that both doors will always fully close. The right hand door is equipped with a three-point latching system that automatically engages when the doors close. Each door is equipped with a fusible-link hold-open feature that will ensure the door closes should the temperature outside the cabinet exceed 165 degrees Fahrenheit. Units 24" long have only one door, self-closing, and equipped with a three-point latching system and hold-open feature. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills. A second pan shall be provided to serve as a full-depth adjustable shelf. Two, 2” diameter, diametrically opposed vents with spark screens shall be provided in the back of the cabinet as well as a grounding screw. The cabinet shall have interior finish same as exterior. The cabinet shall be labeled: "FLAMMABLE - KEEP FIRE AWAY".

3. Vacuum Pump Cabinets:
   Vacuum pump cabinets shall utilize the same gauges of steel and construction features as other base cabinets except they shall be provided without a bottom to allow vacuum pumps and other equipment to be rolled in and out of the cabinet. The interior of the cabinet shall be lined with a 1 inch thick neoprene foam for sound deadening and easy cleaning. Each cabinet shall be furnished with a 120 VAC, 20 amp, duplex receptacle mounted on the inside cabinet back and a pilot lighted toggle switch mounted in the top front panel. Each cabinet shall be furnished with a 1½" diameter PVC vent pipe in the back for venting or access to the fume hood above. The toe kick shall be attached to the doors and shall allow total access to the front of the cabinet. Internal wiring from the switch and pilot light to the receptacle shall not be furnished unless otherwise specified.

D. Upper Cabinet Construction:

1. Upper cabinets shall have a completely finished interior same as exterior and shall be designed so that no mounting hardware is visible when installed.

2. End uprights shall be formed at front, bottom and back to provide maximum strength and rigidity. Front edge of end upright shall be 3/4” wide. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for hinge screws, and shelf adjustment holes.

3. Cabinet tops shall be formed with a 7/8" high C formation at the front edge and turned down at the back to engage a wall hanging rail.

4. Cabinet flush bottoms shall be formed with a 7/8" high C formation at the front edge.

5. Cabinet false bottoms shall be formed down on all four edges and shall be removable.

6. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes. Holes shall be enclosed by end uprights.

7. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear, formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.

   Each adjustable shelf shall include a lip that extends 1/2" above the front edge.

8. Glazed doors shall be 3/4" thick and consist of an inner and outer door pan welded together to form a single unit. Outer door pan shall be 18 gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3" wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18 gauge steel, flanged at all four sides, and pierced for a glass opening in center of the door. Glass shall be held in place by a rubber or vinyl gasket around the entire edge of the glass. Doors shall be glazed with: (Choose one)

a. 1/8" tempered glass

or

b. 1/4" safety glass

9. Solid panel doors shall consist of an inner and outer door pan. Outer door pan shall be formed into a channel or flanged shape at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material.

10. Sliding doors shall be suspended from the top in a roll formed steel track fastened to the cabinet top and shall glide on nylon rollers. Track shall be so designed to prevent accidental removal of doors.

11. Swinging doors under 36" high shall be hung on one pair of hinges, doors over 36" high shall be hung on three hinges.

12. Plate glass doors shall operate on an extruded aluminum track at the bottom of the cabinet, and in an extruded aluminum channel at the top. The bottom of each glass door shall be furnished with a continuous aluminum shoe the full length of the door, which shall be equipped with two nylon rollers that operate on the extruded aluminum track. The aluminum shoes on the bottom of the plate glass doors shall be equipped with pulls for operation of the doors, and also to prevent bypassing of the doors. Plate glass doors shall close against rubber bumpers. Plate glass doors shall be: (Chose one)

    1/4" tempered glass

    or

    1/4" safety glass

E. Steel Full Height Cabinet Construction:

1. Full height storage cabinets shall have a completely finished interior same as exterior.

2. End uprights shall be formed at front, bottom and back to provide maximum strength and rigidity. Front fascia of upright shall be 1-1/4" wide with inside edge formed in a channel 1/2" x 3/8". A full height box reinforcement shall be fitted to the channel, formed to provide a recessed strike for door and to reinforce the cabinet. The backside of the reinforcement shall be perforated with shelf adjustment holes spaced at not more than 1" centers. Back of upright shall be formed in a 2-1/2" formation. 16 gauge hinge reinforcement shall be welded to inner side of front uprights.

3. Cabinet tops shall be formed into a channel shape at front with flange at rear and sides for electro-welding cabinet top to cabinet back and ends. Front fascia channel shall be strengthened with electro-weld reinforcements.

4. Cabinet bottoms for storage cabinets shall be formed down on sides and back to create a square edge transition welded to cabinet end panels, and front edge shall be offset to create a

seamless door recess rabbet for dust stop. Cabinet bottoms shall be formed to provide a flush 1" face rail with a return flange to give a 9/16" deep x 5" high toe space. All cabinets shall have a cleanable smooth interior.

5. Toe space rails shall interlock in back of bottom rail and with end panel to provide a welding plate, and shall extend to the floor with a flange turned back and up for support.

6. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes on not more than 1" centers. Holes shall be enclosed by a formation in cabinet back and enclosed by end uprights.

7. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear; formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation electro-welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.

   Each adjustable shelf shall include a lip that extends 1/2" above the front edge.

8. Glazed doors shall be 3/4” thick and consist of an inner and outer door pan welded together to form a single unit. Outer door pan shall be 18 gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3” wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18 gauge steel, flanged at all four sides, and pierced for a glass opening in center of the door. Door glazing shall be held in place by a rubber or vinyl gasket around the entire edge of the glass. Doors shall be glazed with: (Choose one)

   a. 1/8" tempered glass

or

   b. 1/4" safety glass

9. Solid panel doors shall consist of inner and outer pan formations mechanically assembled after painting. All full height solid panel doors shall be further reinforced by a full-height channel formation welded to inner pan. Doors shall be 3/4" thick and contain sound deadening material.

10. Sliding doors shall be suspended from the top in a roll formed steel track welded to cabinet top and shall glide on nylon rollers. Track shall be so designed to prevent accidental removal of doors.

11. Swinging doors under 36" high shall be hung on one pair of hinges, doors over 36" high shall be hung on three hinges.

F. Apron and Leg Assembly Construction:

1. In general, freestanding tables and/or apron and leg assemblies consist of welded leg assemblies connected to aprons by mechanical fasteners.

2. Table apron rails shall be formed of 16-gauge steel. The rails shall be 4" high, formed top and

bottom into a channel formation. Where drawers occur, the apron rails shall provide the required opening.

3. Table legs shall be 2" square welded tubing. Securely welded to bottom end shall be a 14-gauge die formed gusset with four flanges. A threaded clinch nut shall accommodate a 3/8" 16 x 2-1/2" long leveling bolt. Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling bolts. Use of leg shoe which does not conceal leveling device will not be acceptable.

4. Stretchers shall be constructed of 18-gauge steel and furnished where indicated on drawings. They shall be formed into a 2-7/64" x 1-1/2" channel formation, and secured to table legs by a die-formed clip of 16-gauge steel. Clips shall be welded at ends of channel.

2.05 PERFORMANCE REQUIREMENTS

A. Steel Casework Construction Performance:

1. Base cabinets shall be constructed to support at least a uniformly distributed load 200 pounds per square foot of cabinet top area, including working surface without objectionable distortion of interference with door and drawer operation.

2. Base cabinet leveling bolts shall support 500 pounds per corner, at 1-1/2" projection of the leveling bolt below the cabinet bottom.

3. Each adjustable and fixed shelf 4 feet or shorter in length shall support an evenly distributed load of 40 pounds per square foot up to a maximum of 200 pounds, with nominal temporary deflection, but without permanent set.

4. Full extension soft-close, self-closing ball bearing zinc plated drawer slide shall be rated for 100 pound loads.

5. Swinging doors on floor-mounted inset style casework shall support 200 pounds suspended at a point 12" from hinged side, with door swung through an arc of 160 degrees. Weight load test shall allow only a temporary deflection, without permanent distortion or twist. Door shall operate freely after test and assume a flat plane in a closed position.

B. Steel Paint System Finish and Performance Specification:

1. Steel Paint System Finish:
After Cold Rolled Steel and Textured Steel component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.

After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.

The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS.

2. Performance Test Results (Chemical Spot Tests):

   a. Testing Procedure:
   Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

   b. Test Evaluation:
   Evaluation shall be based on the following rating system.

   Level 0 – No detectable change.
   Level 1 – Slight change in color or gloss.
   Level 2 – Slight surface etching or severe staining.
   Level 3 – Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

   After testing, panel shall show no more than three (3) Level 3 conditions.

   c. Test Reagents

Test No.	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Acid Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle

7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle
12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Acid	Cotton ball & bottle
16.	Dimethylformanide	Cotton ball & bottle
17.	Dioxane	Cotton ball & bottle
18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Acid, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrofluoric Acid, 48%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Cloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Acid, 20%	Watch glass
32.	Nitric Acid, 30%	Watch glass
33.	Nitric Acid, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Acid, 85%	Watch glass
36.	Silver Nitrate, Saturated	Watch glass
37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Acid, 33%	Watch glass
43.	Sulfuric Acid, 77%	Watch glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle
47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Watch glass

* Where concentrations are indicated, percentages are by weight.

3. Performance Test Results (Heat Resistance):
   Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less

than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

4. Performance Test Results (Impact Resistance):
   A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.

5. Performance Test Results (Bending Test):
   An 18 gauge steel strip, finished as specified, when bent 180^{o} over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.

6. Performance Test Results (Adhesion):
   Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197-68, "Standard Method of Test for Adhesion of Organic Coatings".

7. Performance Test Results (Hardness):
   The test sample shall have a hardness of 4-H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8-H is the hardest, and next in order of diminishing hardness are 7-H, 6-H, 5-H, 4-H, 3-H, 2-H, F, HB, B (soft), 2-B, 3-B, 4-B, 5-B (which is the softest).

The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel-like manner until one is found that will cut or scratch the film. The pencil used before that one, that is, the hardest pencil that will not rupture the film, is then used to express or designate the hardness.

2.06 WORKSURFACES

A. Materials:
   1. Basis of Design; Solid Epoxy Resin Tops Durcon, Inc 206 Allison Drive Taylor TX 76574

      Physical properties; minimum acceptable physical performance in accordance with SEFA 3 testing procedures: a. Density/specific gravity: Tested to ASTM D792; minimum test rating of 134.8 PSF or 2.16 gcm. b. Rockwell hardness: Tested to ASTM D785; minimum M scale rating of 110. c. Fire resistance: tested to ASTM D635; classified as self-extinguishing. d. Surface burning characteristics: Tested to ASTM E84; flame spread index 7.4 and smoke develop index of 221.2. e. Surface burning characteristics in vertical position: Tested to ASTM D3801; maximum flame spread index of 7.4 and smoke developed index of 221.2. f. Coefficient of linear thermal expansion: Tested to ASTM D696; rating of 2.46 x 10-5. g. Heat deflection: Tested to ASTM D648; maximum 205 degrees F or 96 degrees C. h. Flexural strength: Tested to ASTM D790; minimum rating 14.9 KPSI or 103 Mpa. i. Flexural modulus: Tested to ASTM D790; 2,777,501

PSI or 19.2 Gpa. j. Water absorption, 24 hours: tested to ASTM D570; maximum 0.008 percent by weight. k. Compression strength: Tested to ASTM D695; minimum 38.4 kpsi or 265 Mpa. l. Chemical resistance; minimum acceptable chemical resistance performance in accordance with SEFA 8: Reagent Tested Method Rating Amyl Acetone A 0 Ethyl Acetate A 1 Acetic Acid 98% B 0 Acetone A 1 Acid Dichromate 5% B 0 Butyl Alcohol A 0 Ethyl Alcohol A 0 Methyl Alcohol A 0 Ammonium Hydroxide, 28% B 0 Benzene A 1 Carbon Tetrachloride A 0 Chloroform A 1 Chromic Acid 60% B 0 Cresol A 0 Dichloro Acetic Acid A 0 Dimethylformanide A 0 Dioxane A 1 Ethyl Ether A 0 Formaldehyde 37% A 0 Formic Acid 90% B 1 Furfural A 0 Gasoline A 0 Hydrochloric Acid, 37% B 0 Hydroflouric Acid 48% B 3 Hydrogen Peroxide 28% B 0 Tincture of Iodine B 0 Methyl Ethyl Ketone A 1 Methylene Chloride A 1 Mono Chlorobenzene A 1 Napthalene A 0 Nitric Acid, 20% B 0 Durcon Incorporated 12 3653-5 Laboratory Worksurfaces 08/23/10 Reagent Tested Method Rating Nitric Acid, 30% B 0 Nitric Acid, 70% B 0 Phenol 90% A 0 Phosphoric Acid, 85% B 0 Silver Nitrate, Saturated B 0 Sodium Hydroxide, 10% B 0 Sodium Hydroxide, 20% B 1 Sodium Hydroxide, 40% B 1 Sodium Hydroxide, Flake B 0 Sodium Sulfide, Saturated B 0 Sulfuric Acid, 25% B 0 Sulfuric Acid, 85% B 1 Sulfuric Acid, 96% B 3 Sulfuric Acid 85%, and Nitric Acid 70%, equal parts B 1 Toluene A 0 Trichlorethylene A 1 Xylene A 0 Zinc Chloride, Saturated B 0 Testing Method Descriptions: Method A - Volatile chemicals (organic solvents): Cotton ball saturated with test reagent is placed in one-ounce bottle (20 x 75mm test tube or similar container) with reservoir of liquid above ball. Container is inverted on test material for period of 24 hours at standard temperature 23 degrees C plus or minus 2 degrees C (73 degrees F plus or minus 4 degrees F). Method B - Non Volatile Chemicals: Five drops (1/4 cc) of test reagent are placed on test material surface. Reagent is then covered with watch glass (25 mm) for period of no less than 24 hours at standard temperature of 23 degrees C plus or minus 2 degrees C (73 degrees F plus or minus 4 degrees F). Result Definitions: 0 - No Effect: No detectible change in material surface. 1 - Good: Slight detectable change in color or gloss but no change to function or life of work surface material. 2 - Fair: Slight surface etching or severer staining. Clearly discernable change in color or gloss but no significant impairment of surface life or function. 3 - Poor: Pitting, cratering or erosion of work surface material; obvious and significant deterioration. Objectionable change in appearance due to surface discoloration. 6. Color: To be *WHITE*

2. Prior approved equal

Performance

1. Thickness: a. 1 inch (25 mm) unless otherwise indicated. b. Check each sheet at factory for required thickness. c. Maximum variation in thickness: plus or minus 1/16 inch (1.6 mm) from corner to corner.
2. 2. Warpage: a. Inspect tops for warpage prior to fabrication by placing on true flat surface. b. Maximum allowable warpage: 1/16 inch (1.5 mm) in 36 inch (900 mm) span or 3/16 inch (4.5 mm) in 96 inch (2400 mm) span.
3. Fabrication: a. Shop fabricate in longest practical lengths. b. Bond joints with highly chemical resistant cement with properties and color similar to base material. c. Provide 1/8 inch (3 mm) drip groove at underside of exposed edges, set back 1/2 inch (13 mm) from face. d. Finish exposed edges.
4. Fabricate tops with 1/4 inch (6 mm) raised marine edge.
5. Corner treatment: exposed corners shall be eased slightly for safety.
6. Back and end splashes: a. Supplied loose for field installation. b. Same material and thickness as worksurfaces. c. 4 inches high unless otherwise indicated. d. Top-mounted end splash where worksurfaces abut adjacent construction at and locations indicated on Drawings.
7. Joints: Maximum 1/8 inch (2 mm), bonded with epoxy grout.
8. Make joints between two benches level.
9. Locate joints away from sinks and over or near supports.

10. Sink cutouts: As indicated on Drawings and routed for undermount sink.
11. Allowable tolerances: a. Square: Plus or minus 1/64 inch (0.4 mm) for each 12 inches (300 mm) of length. Durcon Incorporated 12 3653-7 Laboratory Worksurfaces 08/23/10 b. Location of cutouts and drilled openings: Plus or minus 1/8 inch (3 mm) of design dimension. c. Size of cutouts and drilled openings: Plus 1/8 inch (3 mm) or minus 0 inches (0 mm).

2.07 SINKS CUPSINKS, AND DRAINS

A. Sinks:

1. Molded Epoxy Resin Sinks

B. Cupsinks:
1. Molded Epoxy Resin

2.08 FITTINGS (See Plumbing)

PART 3 — EXECUTION

3.00 SITE EXAMINATION

A. The owner and/or his representative shall assure all building conditions conducive to the installation of a finished goods product; all critical dimensions and conditions previously checked have been adhered to by other contractors (general, mechanical, electrical, etc.) to assure a quality installation.

3.01 INSTALLATION

A. Preparation:
Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.

B. Coordination:
Coordinate the work of the Section with the schedule and other requirements of other work being prepared in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

C. Performance:
1. Casework:
    a. Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.
    b. Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.
    c. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
    d. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8".
2. Worksurfaces:
    a. Where required due to field conditions, scribe to abutting surfaces.
    b. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
    c. Secure worksurfaces to casework and equipment components with materials and procedures recommended by the manufacturer.

D. Adjust and Clean:
1. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.
2. Adjust doors, drawers and other moving or operating parts to function smoothly.
3. Clean shop finished casework; touch up as required.
4. Clean worksurfaces and leave them free of all grease and streaks.
5. Casework to be left broom clean and orderly.

E. Protection:
1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
2. Advise owner and/or his representative of procedures and precautions for protection of

material, installed laboratory casework and fixtures from damage by work of other trades.

SECTION 21 0500 - COMMON WORK REQUIREMENTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 21 and form a part of the contract.

C. Division 22 for Plumbing Systems.

D. Division 23 for Heating, Ventilating and Air Conditioning (HVAC) Systems.

E. Division 26 for Electrical Systems.

F. Division 28 for Fire Alarm Systems.

G. Division 31, for Trenching, Backfilling and Compaction requirements.

H. Division 33 for requirements of site utility systems, including sanitary sewer, storm sewer, domestic water distribution system, and fire main water distribution system.

I. All electrical work, regardless of voltage which is provided under Division 21 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 DESIGN INTENT FIRE PROTECTION SYSTEM

A. Interior Systems

The entire facility shall be protected by wet pipe fire sprinkler systems except as noted below. Each structure will be protected by dedicated fire sprinkler systems fed from the campus water system located in the utility tunnel. Fire sprinklers will be designed throughout utilizing upright heads for exposed areas and pendant heads for areas with finished ceilings. The systems will be configured to protect no more than 52,000 ft² per zone with individual zones protecting each floor level. Each zone shall include a floor control assembly comprised of a supervised grooved butterfly valve, a flow switch, and an inspector's test valve. This arrangement will allow for renovation or repair of portions of the system without compromising the status of adjacent levels. The inspector's test valves will be collocated behind a common access panel at the first floor of each wing. Similarly, the bottom of the elevator pit will be protected with a sprinkler head. The branch line feeding this head shall include a supervised grooved butterfly valve, a flow switch, and an inspector's test valve. The covered portion of the exterior yard will be protected with dry sidewall sprinkler heads.

B. System piping materials will follow traditional selections to include black steel schedule 40 for mains, schedule 10 steel for branches, flexible sprinkler head connections, etc. Backflow prevention will be accomplished using an exterior reduced pressure type device located within a heated enclosure located near the southeast corner of the exterior yard. The fire department Siamese inlet connection will be located on the wall of the enclosure within 100 Ft. of a fire hydrant.

C. Submittals by the fire protection contractor shall be reviewed by the engineer, architect and state code officials for design compliance and head layout. The system shall be hydraulically calculated with detailed design provided by the sprinkler subcontractor. The fire protection system will be designed in accordance with underwriter laboratories (UL), the jurisdictional authority, the owner's insurance carrier requirements (if available) and NFPA requirements. All valves, connections, appurtenances, etc. shall all be provided in accordance with appropriate UL and FM standards. All couplings and fittings used in the installation shall be in accordance with UL standards.

D. No provisions for future expansion will be made within the design of the systems. The sprinkler system will be designed to allow ready conversion of non-instructional spaces into instructional spaces. No post indicator valves will be used within the system. All interior and exterior valves (i.e. backflow preventer OS&Y's) will be monitored through the FACP.

E. The following design densities will be used:

1. Light Hazard Areas — 0.10 gpm per square foot density over the hydraulically most remote 1,500 square feet, with a maximum sprinkler space of 225 sq. ft. in the following locations:

    a. Offices Areas
    b. Restrooms
    c. Help Desk
    d. Breakrooms
    e. Meeting Rooms
    f. Hallways
    g. Vestibules

2. Ordinary Hazard Group I Areas — 0.15 gpm per square foot over the hydraulically most remote 1,500 sq. ft., with a maximum sprinkler spacing of 130 sq. ft. in the following locations:

    a. Mechanical Rooms
    b. Transformer and Switchgear Room
    c. Electric Closets
    d. Computer Labs
    e. IDF Rooms
    f. MDF Rooms
    g. Server Rooms
    h. Elevator Rooms

3. Ordinary Hazard Group II Areas — 0.20 gpm per square foot over the hydraulically most remote 1,500 sq. ft., with a maximum sprinkler spacing of 130 sq. ft. in the following areas:

a. Housekeeping Supply
b. Trash Rooms
c. Records Storage
d. Building Management Storage
e. Other Storage Areas in Excess of 100 sq. ft. containing combustible storage
f. Paint booths

1.3 FIRE SUPPRESSION DIVISION INDEX

Section 21 0500	Common Work Requirements for Fire Suppression
Section 21 0503	Trenching and Backfilling for Fire Suppression
Section 21 0504	Pipe and Pipe Fittings for Fire Suppression
Section 21 0505	Piping Specialties for Fire Suppression
Section 21 0523	Valves for Fire Suppression
Section 21 0548	Vibration and Seismic Control for Fire Suppression
Section 21 0549	Fire Suppression and Electrical Installation Coordination
Section 21 1313	Fire Protection System, Automatic Wet Pipe Sprinkler

1.4 CODES AND PERMITS

A. The fire suppression shall be performed in strict accordance with the applicable provisions of the International Building Code, 2015 Edition; the Uniform Plumbing Code, 2021 Edition; the Uniform Mechanical Code, 2021 Edition and the International Fire Code, 2015 Edition as adopted and interpreted by the State of New Mexico, City of Las Cruces, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding fire protection, heating and ventilating and air conditioning systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. See Division 33 for all requirements associated with utility permits and fees, connections and extensions.

C. The following lists some applicable codes and standards that shall be followed.

Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances
National Electrical Manufacturer's Association Standards
National Electrical Code
Underwriters Laboratories, Inc. Standards
American National Standards Institute
American Society for Testing Materials Standards
Standards and requirements of local utility companies
National Fire Protection Association Standards
American Society of Mechanical Engineers Boiler and Pressure Vessel Codes
Occupational Safety and Health Act

The American Society of Sanitary Engineering

1.5 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up **blue-line prints** showing information on the installed location and arrangement of all mechanical work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. The Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.6 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.7 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements.

1.8 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.9 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.10 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 21, including but not limited to the following:

1. Piping materials, valves, equipment and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all equipment listed on equipment schedules, and in related construction documents.
2. Materials, certification, shop drawings, and other information as specified in the individual Division 21 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

H. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

I. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

J. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

K. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.11 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Mechanical equipment rooms.
2. Piping and piping chases.
3. Complete fire suppression system piping and sprinkler head layout.
4. Layout of all fire suppression equipment.

B. Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems and piping, coordinated with plumbing, HVAC and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the fire suppression systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of fire suppression devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8 inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the mechanical systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. Installation of fire suppression work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.12 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer may require compensation for the time necessary to format the CADD files delivery to the Contractor. Such work will include removal of title blocks, professional for seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.13 PRIOR APPROVAL

A. Equipment manufacturers and service providers are listed within the specifications for the work specified in this division. For the items listed below, the specified manufacturers and providers are the only ones presently approved, and may be the only ones allowed:

1. Plumbing Fixtures and Trim
2. Air Compressor
3. Water Treatment Equipment

B. Manufacturers and service providers who are not listed in these specs, and who offer equivalent or superior products or services, are invited to submit for approval prior to bid (prior approval). Submit two copies. Requests for prior approval must:

1. Include the substitution request form at the end of this spec section.
2. Include technical data sufficient for the Engineer to generally assess appropriateness for this project.
3. Be submitted minimum ten days prior to the bid date in effect at the time of submission.
4. Comply with any additional requirements per specification Division 1.

C. Any additional prior approved alternate manufacturers and service providers will be published in an addendum prior to bid. Prior approval indicates that based on the information submitted it appears to the Engineer that the alternate might be capable of meeting the specifications and the design intent, and might be appropriate for the project. But prior approval does not guarantee this. Prior approved products and service providers must still go through the submittal process after award, and must still comply with the design intent and all specification requirements.

D. Please do not request prior approval for products and service providers that are not listed above. Instead, for those items alternate manufacturers and alternate service providers may be submitted after bid in accordance with the submittal process, provided they meet or exceed the specifications and the indicated design intent.

1.14 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

"The Contractor guarantees that this installation is free from mechanical defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704," or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of fire suppression equipment shall be provided with a full one (1) year parts and labor warranty, from the date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of fire suppression equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

2.2 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 21 0549, Fire Suppression and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The fire suppression piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.3 PAINTING

A. All finish painting of fire suppression systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.4 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve and system valve numbers and designations shall be coordinated with existing valve identification. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 21. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 21 valve tags shall be coordinated with Division 22 and Division 23 valve tags for coordinated format between each division.

2.5 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

1. Adjacent to each valve in piping system.
2. At every point of entry and exit where piping passes through a wall.
3. On each pipe riser and junction.
4. At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
5. Adjacent to all special fittings (regulating valves, etc.) in piping systems.
6. At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow - Hazardous Materials
Green - Liquid Materials of Inherently Low Hazard
Blue - Gaseous Materials of Inherently Low Hazard
Red - Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

I. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Fire Protection Water	White	Red
Fire Auto Sprinkler	White	Red

2.6 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified.

2.7 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.8 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be coordinated with Architect as required to match the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DESIGN AND DRAWINGS

A. The complete design for the project fire suppression system including drawings, hydraulic calculations, piping sizing and arrangement, head layouts, equipment selection, etc., shall be the responsibility of Division 21 Contractor. Preparation of the fire suppression system design shall be in accordance with all Division 21 specification requirements, NFPA requirements and Authorities Having Jurisdiction.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all fire suppression equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within mechanical equipment rooms.

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 21 with the associated architectural, structural, and electrical work than is normally necessary for a more typical facility.

E. The installation of all concealed fire suppression systems shall be carefully arranged to fit within the available space without interference with adjacent mechanical, plumbing, structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed fire suppression systems, including access doors; sprinkler piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the fire suppression system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all fire suppression work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the fire suppression work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Division 21 Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of fire suppression, plumbing and HVAC systems within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; steam and condensate piping; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; heating hot water and chilled water piping; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the mechanical work to the building structure to prevent damage of equipment and systems due to earthquakes. The complete fire protection systems shall be supported as required to resist stresses produced by lateral forces as required by NFPA No. 13. Where fire suppression equipment and piping is connected to the building structure, exact method and means of attachment to the structural system shall be approved by the Architect.

B. See Section 21 0548 for additional requirements for seismic supporting of fire suppression equipment and systems.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of fire suppression equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Architect. Equipment shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gyp board sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Architect.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fire suppression equipment and materials shall be cleaned thoroughly and delivered in a condition satisfactory to the Architect.

3.7 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the fire suppression installation shall be provided by this Contractor.

3.8 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.9 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.10 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

3.11 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of fire suppression equipment herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, bearings, shafts, etc. Furnish two (2) copies of all the literature; each shall be suitably bound in loose leaf book form.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

D. Upon completion of all work and all tests, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

E. Equipment startup and operational test shall be conducted by the Contractor with the assistance of the representatives from the fire pump manufacturers and fire pump controller manufacturer. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.12 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.13 CONSTRUCTION PHASING AND SCHEDULE

A. All work furnished and installed under Division 21 of this Specification shall be provided in accordance with the project schedule and phase and schedule requirements as described on the Architectural Drawings and Specifications.

3.14 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Division 21 Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Division 21 Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.15 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 21 0500

DIVISION 21 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.**
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:
Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____
Proposed Substitution: _____
Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain:_____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades?_____
   _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain:_____
   _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain:_____
   _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain:_____
   _____
9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted _____ Not Accepted: _____ Received too Late: _____
By: _____ Date: _____
Remarks: _____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2:_____

Date: _____

SECTION 21 0503 - TRENCHING AND BACKFILLING FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 21.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplemental General Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0503, for applicable requirements.

END OF SECTION 21 0503

SECTION 21 0504 - PIPE AND PIPE FITTINGS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 21, shall be lead free. The term lead free is defined as pipe which does not contain more than 8.0% lead and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 21 0500 for Common Work Requirements for Fire Suppression.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, seismic restraints, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 21, Section 21 1313 for applicable requirements.

PART 3 - EXECUTION

See Division 21, Section 21 1313, for applicable requirements.

END OF SECTION 21 0504

SECTION 21 0505 - PIPING SPECIALTIES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

C. Section 21 0523, Valves for Fire Suppression.

D. Section 21 0549, Fire Suppression and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0505, for applicable requirements.

END OF SECTION 21 0505

SECTION 21 0523 - VALVES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: Valves shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0523, Valve Identification for Fire Suppression.

C. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

D. Division 23 for Valves.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Fire Suppression system valves shall be UL Listed and FM Approved. See applicable fire suppression system specification sections for additional valve requirements, including hose threads, tamper switches, etc.

B. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Grinnell, Victaulic, Nibco, or Dezurik, or equivalent.

PART 2 - PRODUCTS

See Division 21, Section 21 1313, for applicable requirements.

PART 3 - EXECUTION

See Division 21, Section 21 1313, for applicable requirements.

END OF SECTION 21 0523

SECTION 21 0548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE PROTECTION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Works Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings.

C. Section 21 0900, Instrumentation and Control for Fire Suppression System.

1.3 SCOPE

A. It shall be understood that the requirements for seismic restraints are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements for seismic restraint as specified herein, shown on the drawings and required by Code.

B. The work under this section shall include furnishing all labor, materials, tools, appliances and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed and/or scheduled on the drawings and/or specified in this section of the specifications.

C. The materials and systems specified in this section shall be provided by the Contractor from a single Seismic Snubber Restraint Materials Manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

D. The seismic snubber restraint materials manufacturer shall be responsible for detailed design for seismic supports, including calculation for size and attachment, signed and sealed by registered State of New Mexico Structural Engineer.

1.4 SUBMITTALS

A. See Section 21 0500 for general requirements for submittal materials. In addition to the requirements contained in Section 21 0500, provide submittal information for all products and materials covered under this Section of the Specifications as listed herein.

B. Furnish complete catalog data on all vibration isolators, restraints, and equipment vibration bases to be utilized for the project in order to establish compliance with the plans and specifications and all code requirements.

C. Furnish complete shop drawing information including construction details for all vibration bases; support points and anchor bolt requirements and locations; method of support for piping; method of isolation for piping passing through the building structure; and location and arrangement of seismic restraints.

D. Manufacturers not listed as approved in 'Part 2 - Products' must submit for prior approval in accordance with provisions contained in Section 23 0500.

E. Drawings shall be reviewed and certified by a registered Professional Engineer, with a minimum of five (5) years working experience in this field, certifying that the submitted seismic restraint system design and anchorage details complies with all specification requirements and applicable codes.

1.5 CODE REQUIREMENTS

A. Seismic restraints shall be provided for equipment, materials and systems furnished and installed under Division 21 of this Specification in accordance with the requirements of the 2015 International Building Code; and NFPA No. 13 for fire protection system as adopted and interpreted by the State of New Mexico and the City of Las Cruces.

1.6 PROJECT SEISMIC PARAMETERS

A. The following parameters shall are based on Structural Calculations and should be used to evaluate the seismic requirements of the mechanical systems and components. See structural drawings for additional information:

Seismic Use Group	II
Seismic Response Coefficients	SDS=0.301 SD1=0.143
Site Soil Class	D
Seismic Design Category	C

1.7 SEISMIC RESTRAINT REQUIREMENTS

A. The Contractor shall submit calculations prepared by a State of New Mexico licensed Structural Engineer to substantiate that all items of fire protection equipment and piping systems are properly supported to resist earthquake forces as required herein.

B. All fire protection equipment mounted on vibration isolators shall be provided with seismic restraints securely anchored to the building structure capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

C. All items of fire protection equipment required for life safety including the fire pump and fire protection systems shall be provided with seismic restraints securely anchored to the building

capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

D. All items of fire protection equipment, except as specified above, and all piping furnished and installed under Division 21 shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 50% of their weight.

E. Seismic restraint/snubber manufacturer shall be responsible for the structural design of attachment hardware as required to attach seismic restraints/snubbers to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

F. The Contractor shall furnish a complete set of approved shop drawings of all mechanical and electrical equipment which is to be restrained to the seismic restraint manufacturer, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, installed operating weights of the equipment to be restrained and the distribution of weight at the restraint points.

PART 2 - PRODUCTS

See Division 23, Section 23 0548, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0548, for applicable requirements.

END OF SECTION 21 0548

SECTION 21 0549 - FIRE SUPPRESSION AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 21 0500, Common Work Results for Fire Suppression.

B. Division 22 for Plumbing Systems.

C. Division 25 for Integrated Automation.

D. Division 26 for Electrical.

E. Division 28 for Fire Alarm System.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 21 according to Table 1.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 21	Div. 21	Div. 26	Div. 21
Fire Alarm System & Interface w/Fire Suppression Systems		Div. 28	Div. 28	Div. 28	Div. 28
Fire Pump Systems, including main pump & jacket pump control panels, automatic transfer switches and remote monitoring panels		Div. 21	Div. 21	Div. 26	Div. 21
Fire Sprinkler System Control - Supervisory Panels & Devices, Including Tamper Switches & Flow Switches		Div. 21	Div. 21	N/A	Div. 28

TABLE NOTES:

1. Unless specified to be supplied with the equipment

END OF SECTION 21 0549

SECTION 21 1313 – FIRE PROTECTION SYSTEMS AUTOMATIC WET PIPE SPRINKLER

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplement General Conditions and the General Requirements.

B. Division 3 for concrete work.

C. Division 26 for electrical work and building fire alarm system.

D. Architectural Sections of this Specification for required cutting, patching, painting, required in conjunction with the installation of the new sprinkler system within the existing facility.

1.2 RELATED SECTIONS

Section 21 0500	Common Work Requirements
Section 21 0503	Trenching and Backfilling for Mechanical Systems
Section 21 0504	Pipe and Pipe Fittings
Section 21 0505	Piping Specialties
Section 21 0523	Valves
Section 23 0549	Fire Suppression and Electrical Installation Coordination
Section 23 3000	Air Tempering System and Equipment
Section 28 3100	Fire Detection and Alarm

1.3 SCOPE

A. Criteria: This Section covers the requirements for furnishing the design, fabrication, installation, and acceptance testing of a complete automatic wet-pipe sprinkler system.

B. Classification: In accordance with NFPA 13 and 101 requirements and recommendations.

C. Scope of Work: Provide the design, materials, equipment, fabrication, installation, labor, and supervision necessary to install, disinfect, flush, test, and place into service a complete wet-pipe sprinkler system.

1. Fully sprinkle the facility per NFPA-13, the International Building Code, International Fire Code, state and/or local Fire Marshal, and any specific requirements of the Owner's insurance underwriter.

D. Components: Provide all piping, fittings, control valves, check valves, alarm valve (with trim), tamper switches, fire department connection, sprinkler heads, hangers, bracing, test and drain connections, zone flow switches, tamper switches, accessories and incidentals required for a complete installation in accordance with codes and standards referenced in this Section.

E. Protect all fire lines subject to freezing in a manner approved by NFPA. Use anti-freeze loops only as approved by NFPA and the Local Fire Marshal and only with approved backflow protection in accordance with applicable building codes. Electric heat tape will not be permitted.

F. Conform to the applicable provisions of NFPA Standards 13 and 101 and to the requirements of the International Building Code. Unless otherwise shown on the Drawings or specified, all materials and equipment used in the installation of the fire protection systems shall be listed in the UL Fire Protection Equipment Directory, and shall be the latest design of the manufacturer. All fire hoses, threads and adapters shall match the standards of the City of Las Cruces.

G. Provide temporary fire protection within all areas of the building under construction as required by the building codes and the Fire Marshal.

1.4 QUALITY ASSURANCE

A. All materials and equipment used in the installation of the fire protection systems shall be UL listed and/or FM approved for intended use, unless stated otherwise in these specifications.

B. Contractor Qualifications: Contractor shall be experienced, licensed and regularly engaged in the design, fabrication, and installation of automatic fire protection sprinkler systems.

C. Certification: Welders and brazers shall be qualified per the ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

D. Employ skilled craftspersons and provide proper supervision to ensure the work is erected in a proper manner. Coordinate the work with existing conditions and other disciplines. Visit the premises and thoroughly understand the details of the work and working conditions, and verify all dimensions in the field. If discrepancies are noted which require clarification of the design intent, submit RFIs prior to performing related work. Lay out all work in a manner to avoid all interferences.

E. The drawings show only approximate building outlines and interior construction details as an aid in understanding the scope of work. Follow the drawings as closely as building construction and the work of other trades will permit. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such fittings, traps, valves, and accessories as may be required to meet such conditions. Field verify all dimensions and conditions governing the work.

F. Do not render inoperative any building system without prior approval. Coordinate necessary shutdowns through seven day advanced written notification.

G. Coordinate all fire protection piping and sprinklers with the ceiling or roof materials, lighting, ductwork, conduits, piping, suspended equipment, structural, and other building obstructions to provide an installation in compliance with the appropriate building codes, and NFPA Standards.

1.5 EXISTING CONDITIONS

A. Examine existing conditions and related work required for the design and installation of the fire suppression system.
   1. Perform all field tests and inspections as may be necessary to determine water flow, fire protection and pressure characteristics (static and residual pressure and residual flow) necessary for the design and installation of the fire protection system. Contact the water utility to determine whether they anticipate any degradation in the available water source. Prior to starting design, procurement, and installation, submit to the Owner and Engineer a written report documenting the results of this discussion with the water utility.

1.6 INTERRUPTING SERVICES

A. Coordinate the installation of all work in order to minimize interference with the operation of existing building and mechanical, plumbing, fire protection and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtime. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written approval.

B. All work requiring deactivations of the existing fire protection systems for new connections, relocations, removals, etc, shall be carefully coordinated with the Owner and the Fire Marshal and shall be arranged to minimize system downtime. The Contractor shall provide for all additional costs, as may be required, for work during non-standard hours in order to provide interconnection and interface with the existing fire protection system in order to minimize system deactivation time.

1.7 OPERATION PRIOR TO ACCEPTANCE

A. The Owner may wish to place portions of the fire suppression systems in service prior to substantial completion. In this case, a written agreement will be prepared establishing warranty and other responsibilities to the satisfaction of both parties.

1.8 SUBMITTALS

A. See Division 1 and Section 21 0500 for general submittal requirements.

B. Within 45 days after the contract is awarded, provide submittal data for the complete fire suppression system for review.
   1. Submit sprinkler system design drawings and hydraulic calculations to the Fire Marshal, the Building Department AHJ, and the Owner’s Insurer for review, comment, and approval.
      a. Drawings must be prepared by either a minimum Level 3 NICET Certified Technician, or a professional engineer.
      b. Drawings must be stamped by a professional engineer registered in fire protection.

2. Upon receipt of stamped and approved system design drawings and hydraulic calculations from the Fire Marshal, the Building Department AHJ, and the Owner's Insurer, submit required sets of complete submittal data to the Architect as per spec Section 21 0500.

C. Submit complete data describing all equipment and materials to be furnished including performance, quality, dimensions, and certifications of approving agencies. Include plans showing location and arrangement of water supply connection, control valve, fire department connections, alarm bells, tamper switches, on-site fire main routing, on-site fire hydrants and other equipment to be used; and including head layouts coordinated with lighting, plumbing and air conditioning systems. Submittals shall include the following:

1. Shop drawings.
2. Certifications (after installation and tests are completed).
3. Equipment list.
4. Material list.
5. Installation instructions.
6. Maintenance instructions.
7. Operating instructions.
8. Samples, colors.
9. Welder's certification.
10. Catalog data (appropriate unit identified on cut).
11. Recommended spare parts lists.
12. Verifiable calculations.
13. Nameplate data.

D. Complete Package: Submit fire suppression work as a complete package to permit analysis of the system(s) and its components. Partial submittals will not be accepted.

E. Hydraulic Calculations: Submit computerized hydraulic calculations. Maintain a minimum of 10 percent, but not less than a 5 psi buffer below the final water supply curve after accounting for required hose streams, pipe friction elevation differences, etc. Hydraulic design sprinkler system shall be in accordance with the following:

1. Sprinkler System Occupancy Hazard Classifications:

   a. Office and Public Areas: Light Hazard
   b. Storage Areas: Ordinary Hazard
   c. Equipment Rooms: Ordinary Hazard
   d. Service Areas: Ordinary Hazard

2. Minimum Density Requirements for Automatic Sprinkler Hydraulic Design:

   a. Light Hazard Occupancy: 0.10 gpm over 1500 sf area.
   b. Ordinary Hazard, Group 1 Occupancy: 0.15 gpm over 1500 sf area.
   c. Ordinary Hazard, Group 2 Occupancy: 0.20 gpm over 1500 sf area.
   d. Special Occupancy Hazard: As determined by authority having jurisdiction.

F. Shop Drawings: Minimum 1/8" = 1'0" for plans, and 1/4" = 1'0" for details, with minimum 3/16 inch lettering. Show all piping, sprinklers, hangers, flexible couplings, roof construction,

electro-mechanical devices, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. Show hydraulic reference points and remote areas.

G. Record Drawings: Provide mylar reproducible record drawings and AutoCAD 2008 files showing all work under this contract. Indicate any special systems or devices such as dry pendant heads, antifreeze loops, inspector's test connections, etc. Submit record drawings prior to requesting final payment.

1.9 PRODUCT HANDLING

A. Materials and Equipment: Protect materials and equipment from damage during shipping, storage, and installation.

B. Materials and Equipment Installation: Ensure materials and equipment are free of moisture, scale, corrosion, dirt, and other foreign materials prior to installation.

C. Plugs and Cover Plates: Protect flanged openings with gasketed metal cover plates to prevent damage during shipment. Cap or plug all drains, vents, and small piping or gauge connections.

D. Sprinkler Head Protection: Remove frangible bulb protectors after sprinkler heads are installed. Protect sprinkler heads with factory-supplied caps and covers until ceiling installation is complete.

1.10 ENVIRONMENTAL CONDITIONS

A. The sprinkler system and system components shall be designed to operate at an elevation of 3,900 feet above sea level and in freezing temperatures when exposed to outside conditions.

1.11 ALARM FACILITIES

A. Provide water flow switches and tamper switches. Integrate these and other required sprinkler system alarm devices into the building fire alarm system provided under Division 26. Coordinate with Division 26, Fire Detection and Alarm, regarding the requirements and location of items provided under this section which must be integrated with the fire alarm system.

B. Provide tamper switches on all required valves and devices used in conjunction with the building fire protection system.

1.12 ELECTRICAL CONNECTIONS

A. The fire alarm system will monitor waterflow indicators, tamper switches, etc., provided under this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All material and equipment furnished shall be in accordance with the following requirements and NFPA 13. All fire protection materials and equipment shall be new and unused, shall be free of defects and specifically designed for the use intended, shall conform to the requirements of NFPA 13, and shall be UL listed and FM approved, unless otherwise noted in the Specification.

B. Any deviation to the above requirements shall be submitted to the Architect for approval. The deviation submittal shall be clearly identified as a "deviation."

2.2 PIPING MATERIAL

A. Material Requirement: Automatic sprinkler piping shall be in accordance with this Section and NFPA 13, respectively.

B. Underground piping, to a point 5'0" from the building perimeter, shall be as specified for underground water services in Division 33, Outside Utilities, of this Specification.

C. Underground piping within the building and to a point 5'0" from the building perimeter shall be AWWA Class 200 ductile iron water main pipe and fittings with mechanical joints. Interior of pipe and fittings shall be cement lined. Exterior of pipe and fittings shall be bituminous coating or equivalent. All changes in direction shall be adequately blocked or strapped to prevent separation of joints.

D. Interior building piping systems shall be black steel pipe ASTM A120, or A53 Grade A or B, ERWQ or BW, Standard wall, Schedule 40. UL and FM approved thin wall (Schedule 10, minimum) ASTM A135 or A795 piping may be utilized for sprinkler system as allowed by NFPA and the Fire Marshal. Piping installed outside or exposed to outdoor ambient conditions shall be galvanized.

2.3 FITTINGS

A. Changes of direction shall be accomplished by the use of fittings suitable for use in sprinkler systems as defined in Article 3-13 of NFPA 13. Fittings installed outside or exposed to outdoor ambient conditions shall be galvanized.

B. Fittings and specials for ductile iron pipe shall be Class 250 to match pipe, conforming to AWWA C110, mechanical flange joint type. All ductile iron fittings shall be cement lined.

C. Fittings for steel pipe shall be cast iron screwed, welded fittings, or UL and FM approved mechanical pipe couplings and fittings as manufactured by Victaulic or equivalent in accordance with requirements specified in Section 21 0504.

2.4 JOINTS

A. Joints shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings, and the manufacturer's instructions. Threaded joints for thin-wall (Schedule 10) piping shall be provided in strict accordance with NFPA requirements, UL and FM approvals for threadable thin-wall piping

2.5 UNIONS AND FLANGES

A. Unions and flanges shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings. Gaskets shall be as recommended by the manufacturer and suitable for service on which used.

2.6 HANGERS AND SUPPORTS

A. See Section 21 0504, Pipe and Pipe Fittings, for general requirements associated with equipment piping systems hangers and supports. Seismic supports for fire protection system shall be provided in accordance with NFPA requirements.

B. All fire protection piping shall be rigidly supported from the building structure by means of adjustable ring type hangers. Piping hangers shall be spaced as specified in NFPA 13, Chapter 2. Piping system shall be installed in an approved manner and shall not overload the structure. The Contractor shall provide additional hangers and steel support members as may be required to distribute the piping weight over several structural members where required or directed. Fire protection piping system shall be supported independent and shall not be attached or supported from hangers, trapezes, or supports provided for other piping systems or equipment.

2.7 VALVES

A. See Section 21 0523, Valves, for general valve requirements. All valves for fire hose fire department connections shall have threads and adapters to match the standard of the City of Las Cruces Fire Department. All valves shall be UL listed and FM approved. Valve sizes shall be determined by the approved hydraulic calculations. Outside screw and yoke valves shall be indicated on the approved hydraulic calculations. Tamper switches shall be provided on all valves controlling fire protection system operation, as required by NFPA. Valves shall be rated for working pressure not less than the maximum pressure to be developed at that point in the system under any operating condition.

B. Gate valves 2" and under, shall be bronze body and trim, outside screw and yoke, wedge disc, screwed connections, 400 psi W.O.G. maximum working pressure.

C. Gate valves, 2-1/2" and larger, shall be Class 125 or Class 250, as required, with flanged ends, outside screw and yoke, bronze seals, wedge disc, iron body.

D. Drain valves shall be globe valve or angle body globe valve, with screwed ends, bronze body and trim, 200 psig W.O.G. maximum working pressure. Furnish and install as required by NFPA No. 13.

E. Swing check valves 2" and smaller shall be y-pattern, horizontal swing bronze body, bronze trim, 200 psig W.O.G. screwed connections.

F. Swing check valves 2-1/2" and larger, shall be iron body, clearway swing check, Class 125 or Class 250 as required with flanged or grooved connections.

G. Automatic Ball Drips: Automatic ball drips shall be 1/2" or 3/4" as required normally open, which close when the flow of water through the valve exceeds 4 to 10 gpm, 175 psig working pressure, Underwriters' Laboratories, Inc., or Factory Mutual approved, Standard Fire West No. 5248 or equivalent.

H. Post indicator fire main control valve shall be vertical post type for underground valve control or wall type provided as shown on the Drawings, Underwriters' Laboratories, and Factory Mutual approved pattern with approved gate valve and tamper switch. See Section 22 680 for vertical post indicated and underground valves. Vertical post indicator shall be Mueller Co. Model A-20804 with Mueller AWWA non-rising stem gate valve, A-2050 Series or equivalent. Wall type indicator shall be Mueller A-20810 or equivalent.

2.8 ALARM CHECK VALVES

A. Furnish complete wet-pipe sprinkler system alarm check valve assembly with all accessories required for system operation, supervision and alarm. Valves shall be UL listed and FM approved, designed to automatically activate electrically and/or hydraulically operated alarms and shall be furnished in the required size and arrangement with either flanged or grooved connections.

B. Furnish retard chamber, pressure gauges, valves, and trim including water motor gong and alarm switch with both normally open and normally closed electrical contacts.

C. Alarm check valve assembly shall be as manufactured by Tyco Fire Products or equivalent.

2.9 PRESSURE GAUGES

A. Pressure gauges shall be designed for use with water. Gauges shall be of the Bourdon type having an enclosed phosphor-bronze type. The moving parts shall be brass or stainless steel except the hairspring, which is phosphor-bronze. The case and ring shall be brass or stainless steel, and the ring shall be either threaded or pressed over the case. Gauges shall be 4-1/2 inch size with dial marking subdivisions no finer than one percent of the maximum scale reading, and shall be accurate to two percent or less. The gauge scale, when possible, shall be at least twice the maximum working pressure. All gauges shall be FM approved and UL listed.

2.10 TAMPER SWITCHES

A. All valves which control water to automatic sprinkler heads shall be equipped with supervisory switches having one normally open contact and one normally closed contact. Valve supervisory switches shall be single pole double throw switching contacts, and shall be housed in a gasketed weathertight enclosure. The supervisory device supplied shall be specifically designed to mount on, and operate reliably with, the type of control valve being monitored. All valve position

switches shall be adjusted to transmit a supervisory signal within two revolutions of the valve operating hand wheel or crank (away from its full open position).

2.11 FLOW SWITCHES

A. Water flow switches shall be field adjustable vane-type with pneumatic retard and 175 psi working pressure. Units shall be single pole double throw, normally open, suitable for 24-volt, DC service or as otherwise required to interface with Building Fire Alarm system. Water flow switches shall be adjusted so that the device will transmit a water flow alarm within 90 seconds of opening the inspector's test valve on the sprinkler system. The flow switch shall be furnished and installed under this Section of Specifications and electrically connected under Division 26. Flow switches when required for zoning shall be piped and installed so that only one flow switch actuates when an alarm in that zone is present.

2.12 SPRINKLER HEADS

A. Sprinkler heads and accessories shall be UL listed or FM approved for the intended service, regular automatic closed type, 165 deg F rated with 1/2" orifice, except as may be otherwise required for the specific application, and subject to NFPA 13 and 101 requirements and recommendations. Sprinkler heads with higher temperature ratings shall be installed in electrical and mechanical equipment areas, in areas where occupancy may generate high ambient temperatures, where installed in the vicinity of heat producing equipment, attic spaces, where exposed to the direct rays of the sun and beneath skylights and windows, and at other such locations as required by NFPA 13. Sprinkler heads throughout the exterior yard #140 and all adjoining spaces shall be 286°F. rated.

B. Sprinkler heads installed in unfinished areas without suspended ceilings shall be upright bronze or brass. Sidewall type heads may be used in areas with low headroom as approved by the Fire Marshal.

C. Sprinkler heads in areas with suspended ceilings including toilet facilities, storage rooms, and similar building spaces shall be chrome plated bronze pendant type or white painted finish as selected by the Architect unless otherwise noted. Sidewall heads in finished areas shall be horizontal, chrome plated bronze.

D. For all building areas, except as indicated above, furnish concealed sprinkler heads consisting of sprinkler head installed within brass enclosure assembly with cover plate with white finish or satin chrome, as approved by the Architect.

E. Supply spare heads of each type as required by NFPA 13. Provide a metal cabinet with a sprinkler head wrench for each type head.

F. Provide sprinkler head guards where required by NFPA 13 and where appropriate.

G. Approved Manufacturers: Tyco Fire Products, Viking, or equivalent.

2.13 SYSTEM ACCESSORIES

A. Fire Department Connections: Fire department connections shall be of the type and style shown on the civil fire protection drawings, cast brass body, double clappers, plugs, and attached chains. All exposed surfaces, caps and chains shall be chrome plated. Identification shall be by raised letters on the individual devices, or shall consist of attached escutcheon plates of the same material. Label shall read "AUTO SPKR". The dimension from grade level to the center of the 2-1/2-inch inlets shall be 34 inches (plus or minus 2 inches). Make the fire department connection above the inlet to the alarm valve.

B. Plaques: Main riser plaques shall be 7 inches by 10 inches with four mounting holes (one in each corner), and shall have white lettering on red porcelain with white blank for the "design data." Plaque shall meet all requirements of NFPA 13, Chapter 7.

C. Strainers: Strainers, where required, shall be "Y" type with cast iron body, 30 mesh monel screen, flanged ends, 1-1/2-inch blow down connection discharging to outside, and shall be rated at 175 psi working pressure for cold water service.

D. Splash Blocks: Splash blocks shall be concrete, 12 inches by 24 inches by 4 inches thick. A commercially available splash block may be provided as a suitable alternate.

2.14 ACCESS DOORS

A. All concealed valves, controls, etc., shall be provided with access doors as specified under Section 21 0500, Common Work Requirements.

PART 3 - EXECUTION

3.1 FIELD CONDITIONS

A. Prior to installation the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where the installation of the sprinkler system may properly commence.

B. The Contractor shall verify that the entire sprinkler system may be installed in accordance with all referenced codes, regulations, standards, and the original approved design.

3.2 INSTALLATION

A. General

1. The complete fire protection system shall be installed in accordance with NFPA 13. The project drawings provide general information concerning the system arrangements, equipment, material, sizes, and other requirements and shall be utilized by the Contractor for this purpose. However, the Contractor shall have complete responsibility for the system design and installation in accordance with the requirements of this Specification.
2. All pipe, fittings, valves, equipment, and accessories shall be visually examined to ensure that they are clean and free of all burrs, cracks, and other imperfections before being

installed. During the progress of construction, open ends of pipes, fittings, and valves shall be properly protected at all times to prevent admission of foreign matter.

B. Piping

1. Installation of fire sprinkler piping system shall be in accordance with all applicable requirements contained in Section 21 0500 – Common Work Requirements, Section 21 0504 – Pipe and Pipe Fittings, and Section 21 0505 – Piping Specialties.
2. All fire sprinkler piping shall be so arranged and include such devices to separate the system into individual and distinct alarm zones as shown on the contract drawings and as required by NFPA recommendation and the Fire Marshal. A minimum of one zone per floor will be required unless shown otherwise on the contract drawings.
3. Sprinkler piping shall be marked and identified in accordance with Section 21 0500, Common Work Requirements.
4. The arrangements of all piping systems shall conform to Architectural requirements and field conditions, and shall be run straight and direct, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be provided where required. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, and shall be parallel with the walls and other pipes and shall be neatly spaced. All work shall be coordinated with all Sections of Division 21, 22, and 23, and Division 26, "Electrical," in order to avoid interference of pipe and unnecessary cutting of floors and walls.
5. No pipes or other apparatus shall be installed so as to interfere in any way with the full swing of the building doors, access doors, equipment access, etc.
6. Inspector's test and test pipes shall be piped from the end of the most remote branch line of the automatic sprinkler system to the exterior of the building.
7. When trapped capacity is more than five gallons, provide auxiliary drains consisting of a one-inch valve, nipple, and cap. When trapped capacity is less than five gallons, auxiliary drain shall be one-inch nipple and cap or plug.
8. Provide main drain valves at system alarm valves and extend piping to discharge at exterior at a location approved by the Architect. All pipe and fittings downstream of drain valve shall be galvanized.
9. All concrete penetrations shall be sleeved, then grouted and sealed with fire-resistive material that shall be securely held in place.

C. Welding

1. No field welding of sprinkler piping shall be permitted.
2. Headers, risers, feed, crossmains, and branch lines may be shop welded using approved welding fittings. Welding and brazing shall conform to American National Standard Institute for Power Piping, ANSI B 31.10, with Addenda ANSI B 31.10a and ANSI B 31.10b. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler systems.
3. Provide a blind flange at each end of welded headers.
4. Welders and brazers shall be certified for welding and/or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators. Welders must be certified for work they perform, and certificates shall be checked before the work commences.

D. Alarm Check Valve: Alarm check valves shall be installed with the valve and trim set plumb, and shall be unobstructed. Clear distances shall be as listed below:

Rear: 12 inches
Sides: 18 inches
Front: 24 inches

E. Control Valves: OS&Y fire protection control valves shall be installed so that the stem can be readily seen.

F. Sprinklers and Accessories

1. Sprinkler heads in finished areas are to be installed on a true axis line in both directions with a maximum deviation from the axis line of 1/2" plus or minus. Heads exceeding this shall be removed and reinstalled. Sprinkler heads shall be located in the center of the ceiling tiles, unless otherwise directed.
2. Provide chrome-plated escutcheons where exposed piping passes through finished floors, walls, partitions, and ceilings. Secure plates to pipe with setscrews or spring clips.
3. Provide spare sprinkler head cabinets per NFPA 13.

3.3 EQUIPMENT INSTALLATION

A. Installation of all devices or equipment not specifically covered by these Specifications shall be in accordance with manufacturer's instructions.

3.4 TEMPORARY FIRE PROTECTION

A. During the construction of the building and until the permanent fire extinguishing system has been installed and is in service, temporary fire protection shall be provided as required by the Fire Marshal.

3.5 INSPECTION AND TESTING

A. The complete fire protection systems and piping acceptance testing shall be performed by the Contractor and witnessed. Advance notice shall be given by the Contractor prior to any tests.

B. Inspection Prior to Testing: The Contractor shall submit notification upon completion of the installation of all materials and equipment.

C. Water Piping Disinfection: The Contractor shall furnish all hoses, connections, and equipment to flush piping clear and free of debris and to rinse piping of disinfectant. Flushing per NFPA Figure A-10.10-2.1. All fittings and connections required for water piping, flushing, and disinfection shall be furnished by the Contractor.

D. Chlorine Application: Water from the existing distribution system, or other approved supply source, shall be made to flow at a constant measured rate into the newly installed piping. The water shall receive a minimum chlorine dosage of 300 mg/1. The Contractor shall not allow any anti-freeze glycerine to come in contact with the chlorine. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of chlorinated water that will

expose all interior surfaces to a concentration of at least 30 mg/1 for at least three hours. The application shall be checked at a tap near the downstream end of the line by chlorine residual measure. The chlorine residual measurement test shall be performed by the Contractor and the results submitted.

E. Final Flushing: After the applicable retention period, the heavily chlorinated water in the entire system shall be flushed until the chlorine concentration is not higher than that of the source.

F. Pressure Testing: Pressure tests shall consist of at least flushing, hydrostatic testing, and operation testing and shall be performed in strict accordance with the requirements of NFPA 13. For all above-grade piping, test pressure of 200 psi shall be held for a continuous period of two hours with no drop in pressure. Each complete system (main riser with all associated piping and alarms) shall be tested and accepted as a complete unit. System pressure test shall be against a blank test flange and not against a valve seat. Tests may be conducted by the Contractor on small sections of each complete unit for the benefit of the Contractor. An air pressure test may be provided in accordance with NFPA 13. An air pressure of 40 psig shall be pumped up, allowed to stand 24 hours, and all leaks which allow a loss of pressure over 1.5 psig during the 24 hours shall be fixed.

G. Unsatisfactory Tests: If any of the above tests fail to produce satisfactory results, tests shall be repeated at no additional cost to the Owner until satisfactory results have been obtained.

3.6 CERTIFICATION

A. The Contractor shall certify that the system has been installed in accordance with all referenced codes and standards. The Contractor shall submit this certification upon completion of tests.

3.7 MAINTENANCE AND OPERATING INSTRUCTIONS

A. System description, system theory of operation, and system final inspection and acceptance documents of the completed system shall be submitted in a bound book (four copies). The maintenance manuals and instructions shall include a brief description of the type of system installed, routine-type work defined by step-by-step instructions that should be performed to ensure long life and proper operations, and the recommended frequency of performance. The instructions shall also include possible trouble spots with diagnosis and suggested correction of each. The theory of operation brochures shall describe the function of each component or subassembly. A copy of the completed Contractor's Materials and Test Certificate (reference NFPA-13, Chapter 24) shall be included to document the final inspection, operating test, acceptance and placement of system in service.

END OF SECTION 21 1313

SECTION 09 2900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent Sections of Division 22 and form a part of the contract.

C. Division 21 for Fire Suppression Systems.

D. Division 23 for Heating, Ventilating & Air Conditioning (HVAC) Systems.

E. Division 26 for Electrical Systems.

F. Division 31 for Trenching, Backfilling and Compaction requirements.

G. Division 33 for requirements of site utility systems including sanitary sewer, storm sewer, and domestic water distribution system.

H. All electrical work, regardless of voltage which is provided under Division 22 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 PLUMBING DIVISION INDEX

Section 22 0500	Common Work Requirements for Plumbing
Section 22 0503	Trenching and Backfilling for Plumbing
Section 22 0504	Pipe and Pipe Fittings for Plumbing
Section 22 0505	Piping Specialties for Plumbing
Section 22 0523	Valves for Plumbing
Section 22 0549	Plumbing and Electrical Installation Coordination
Section 22 0700	Plumbing Insulation
Section 22 1100	Domestic Water Piping
Section 22 1123	Facility Natural Gas system
Section 22 1316	Sanitary Waste and Vent Piping
Section 22 1400	Facility Roof Drainage
Section 22 1500	Compressed-Air systems
Section 22 4000	Plumbing Fixtures and Trim

1.3 CODES AND PERMITS

A. The plumbing work shall be performed in strict accordance with the applicable provisions of the International Building Code, 2015 Edition; the Uniform Plumbing Code, 2021 Edition; the Uniform Mechanical Code, 2021 Edition and the International Fire Code, 2015 Edition as adopted and

interpreted by the State of New Mexico, City of Las Cruces, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding plumbing systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. See Division 33 for all requirements associated with utility permits and fees, connections, extensions, meter pits, and meter sets.

C. The following lists some applicable codes and standards that shall be followed.

1. Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances.
2. National Electrical Manufacturer's Association Standards
3. National Electrical Code
4. Underwriters Laboratories, Inc. Standards
5. American National Standards Institute
6. American Society for Testing Materials Standards
7. Standards and requirements of local utility companies.
8. National Fire Protection Association Standards
9. American Society of Mechanical Engineers Boiler and Pressure Vessel Codes
10. Occupational Safety and Health Act
11. Commercial and Industrial Insulation Standards (MICA)
12. American Gas Association
13. The American Society of Sanitary Engineering
14. National Sanitation Foundation

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all plumbing work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take ‘as-built’ measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 22, including but not limited to the following:

1. Piping materials, valves, insulation materials and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all plumbing equipment listed on equipment schedules, and in related construction documents.
2. Materials, certification, shop drawings, and other information as specified in the individual Division 22 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

H. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of plumbing and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

I. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted

shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

J. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

K. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Equipment rooms, and other spaces housing plumbing and equipment, etc.
2. Piping and chases.
3. Complete plumbing piping systems located within the building.
4. Layout of all plumbing equipment.

B. Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems, including piping, coordinated with HVAC plumbing, fire suppression and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the plumbing systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, sprinkler heads, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of plumbing devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8 inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the plumbing systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. Installation of plumbing work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.11 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.12 PRIOR APPROVAL

A. Equipment manufacturers and service providers are listed within the specifications for the work specified in this division.

B. Manufacturers and service providers who are not listed in these specs, and who offer equivalent or superior products or services, are invited to submit for approval prior to bid (prior approval). Submit two copies. Requests for prior approval must:

1. Include the substitution request form at the end of this spec section.
2. Include technical data sufficient for the Engineer to generally assess appropriateness for this project.
3. Be submitted minimum ten days prior to the bid date in effect at the time of submission.
4. Comply with any additional requirements per specification Division 1.

C. Any additional prior approved alternate manufacturers and service providers will be published in an addendum prior to bid. Prior approval indicates that based on the information submitted it appears to the Engineer that the alternate might be capable of meeting the specifications and the design intent, and might be appropriate for the project. But prior approval does not guarantee this. Prior approved products and service providers must still go through the submittal process after award, and must still comply with the design intent and all specification requirements.

D. Please do not request prior approval for products and service providers that are not listed above. Instead, for those items alternate manufacturers and alternate service providers may be submitted after bid in accordance with the submittal process, provided they meet or exceed the specifications and the indicated design intent.

1.13 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

"The Contractor guarantees that this installation is free from defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704", or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of plumbing equipment shall be provided with a full one (1) year parts and labor warranty, from the date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of plumbing equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCS, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 3,900 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL SERVICES - MOTORS

A. Each motor, unless otherwise specified of 3/4 HP and greater, shall be designed for operation with 3 phase, 60 Hz, 460 volt electrical service. Unless otherwise specified, motors of 1/2 hp and less shall

be designed for operation with single phase, 60 Hz, 120 volt electrical service. Motors shall be 1750 RPM, squirrel cage, normal starting torque and normal starting current, in accordance with NEMA standards unless otherwise specified.

B. All T-frame, ODP motors 5 HP and above shall be premium efficiency motors with a minimum power factor of 0.85 on 1800 RPM motors and a minimum efficiency rating in accordance with IEEE Standard 112, Test Method 'B' as scheduled below. In addition, all motors used in conjunction with variable frequency drives shall be premium efficiency.

NEMA EFFICIENCY	
Motor Horsepower	Efficiency, Minimum
5	90.2
7-1/2	91.0
10	91.7
15	92.4
20	93.0
25	92.4
30	93.0
40	93.6
50	93.6
60	93.6
75	95.0

C. Motors, including premium efficiency motors shall be manufactured by General Electric Baldor, Louis Allis (Spartan), Marathon, Reliance Electric, Westinghouse, or equivalent having equal efficiencies.

D. Special motors as may be necessary by the application and as specified herein and on the drawings include C-FACE, totally enclosed fan cooled (TEFC),explosion-proof, etc., shall be provided as required and shall be furnished manufacturer's premium efficiency rating for 5 HP and larger.

E. Each motor shall be of the horsepower as specified and suitable for use at an altitude of 3,900 feet. All motors shall have grease lubricated sealed ball bearings. Motors larger than 1 HP shall have a standard grease fitting "Zerk" and a separate grease relief tapping. Motors shall be factory lubricated. Motors shall be commercially dynamically balanced and tested at the factory before shipment and shall be selected for quiet operation. The Contractor shall line up motors and drives and place motors and equipment on foundations ready for operation.

F. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 400C rise and total temperature rise of 65oC ambient and when powered from the system voltage feeding the motor. TEFC motors shall have a service factor of 1.00 with total temperature rise of 65oC in the above conditions. Motors located in areas exceeding 40oC in the ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Unless otherwise specified for a particular application use electric motors with the following requirements.

1. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

2. Polyphase Motors: NEMA Design B, Squirrel cage, induction type. Each two speed motor shall have two separate windings.
3. Rating: Continuous duty at 100% capacity in an ambient temperature of 40oC.

G. If the Division 22 Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with Division 26 and shall pay all additional charges in connection with the change.

2.4 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 22 0549, Plumbing and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.5 PAINTING

A. All finish painting of plumbing systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.6 COUPLING GUARDS

A. All flexibly connected pumps shall be provided with protective steel coupling guards.

2.7 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve and system valve numbers and designations shall be coordinated with existing valve identification. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 22. Valves shall be listed by system, i.e. domestic cold water, hot water, chilled water etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 22 valve tags shall be coordinated with Division 21 and Division 23 valve tags for coordinated format between each Division.

C. Valve tags shall be coordinated with existing facility valve tags and Contractor shall obtain a copy of existing facility valve chart and provide updated valve chart to the Owner's Representative.

2.8 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

1. Adjacent to each valve in piping system.
2. At every point of entry and exit where piping passes through a wall.
3. On each pipe riser and junction.
4. At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
5. Adjacent to all special fittings (regulating valves, etc.) in piping systems.
6. At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow - Hazardous Materials
Green - Liquid Materials of Inherently Low Hazard
Blue - Gaseous Materials of Inherently Low Hazard
Red - Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

I. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Domestic Cold Water	White	Green
Domestic Hot Water	Black	Yellow
Domestic Hot Water Return	Black	Yellow
Soft Cold Water	White	Green
Soft Hot Water	Black	Yellow
Industrial (non potable) Cold Water	White	Green
Reverse Osmosis	White	Green
Compressed Air	White	Blue
Roof Drain	White	Green
Sanitary Sewer	White	Green
Storm Sewer	White	Green

2.9 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the contract drawings.

2.10 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.11 EQUIPMENT TAGS

A. Furnish and install equipment identification tags for all items of PLUMBING equipment furnished and installed under Division 22. Equipment tags shall be a minimum of 3/32" thick laminated phenolic plastic.

2.12 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be coordinated with Architect as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the plumbing work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The plumbing drawings show the general arrangement of all piping, fixtures, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents, including but not limited to Division 21 Fire Suppression, Division 23 HVAC, and Division 26 Electrical shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural and Structural drawings shall take precedence over the plumbing, HVAC and fire suppression drawings. Install plumbing fixtures, floor drains, floor sinks, roof drains, etc. in locations as indicated on Architectural drawings. Because of the small scale of the plumbing, HVAC and fire suppression drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such

conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefore shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior written approval. All changes shall be marked on the set of record drawings by the Contractor.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all plumbing equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within equipment rooms.

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 22 with the associated architectural, structural, and electrical work than is normally necessary for a more typical facility.

E. The installation of all concealed plumbing systems shall be carefully arranged to fit within the available space without interference with adjacent structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed plumbing systems; access doors; piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the plumbing system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all plumbing work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the plumbing work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of plumbing, HVAC and fire suppression equipment within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; steam and condensate piping; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; heating

hot water and chilled water piping; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. Plumbing equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Architect. Equipment and materials shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with caps, with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gypboard sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Architect and Owner’s Representative.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the plumbing work, fixtures and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect.

3.6 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the plumbing installation shall be provided by this Contractor.

3.7 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.8 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of plumbing equipment unless specifically deleted by the specifications or drawings.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all vibration isolators, anchor bolts, etc.

C. Contractor shall provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.9 EQUIPMENT FURNISHED UNDER OTHER SECTIONS OF THESE SPECIFICATIONS

A. Certain items of mechanical equipment as listed on the drawings and/or specifications will be furnished under other sections of this specification for mechanical rough-in and connection under Division 22, including plumbing, domestic water and waste, cooling water, compressed air, etc. All required plumbing services, including connection of such services to equipment shall be provided under Division 22.

3.10 ALIGNMENT OF FLEXIBLE COUPLINGS

A. Flexible couplings between motors and driven equipment shall be aligned by the qualified service technician after the equipment is installed and ready for operation. Proper aligning shall be provided within manufacturer's maximum alignment tolerance at equipment operating conditions and temperature. Alignment shall follow unit manufacturer's written procedures using approved dial indication methods for parallel and angular alignment. The Contractor shall provide written certification that each device has been so aligned.

3.11 LUBRICATION

A. The Contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation and shall thoroughly grease the steel shafts to prevent corrosion. Bearings

for items of plumbing equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

3.12 PRESSURE RELIEF DEVICES

A. Pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with Code requirements.

3.13 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.14 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

1. End Suction Pumps
2. Water Softener
3. Domestic Water Generators
4. Sump Pump and Sewage Pump Systems
5. Domestic Water Booster Pump Systems

3.15 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of plumbing equipment fixtures, faucets, etc., herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, bearings, shafts, etc.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

D. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the plumbing systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

E. Operational test shall be conducted by the Contractor with the assistance of the equipment manufacturer's representative or service technician. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.16 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.17 INTERRUPTING SERVICES

A. The Contractor shall coordinate the installation of all plumbing work onsite and within the building in order to minimize interference with the operation of existing building and onsite mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

3.18 CONSTRUCTION PHASING AND SCHEDULE

A. All work furnished and installed under Division 22 of this Specification shall be provided in accordance with the project schedule and phase requirements as described on the Architectural Drawings and Specifications.

3.19 PLUMBING SYSTEM SHUTDOWN AND REACTIVATION

A. The Contractor shall shutdown existing facility plumbing equipment and piping systems as required for installation of the project plumbing construction work. As a part of the required work, the Contractor shall drain down the existing systems and after completion of new work and pressure testing of systems, the Contractor shall refill the systems and re-establish proper system circulation, remove all air from piping system and equipment, and place system in full and proper operation.

3.20 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Division 22 Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the

Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Division 22 Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

B. Prior to the "Final" observation visit, the attached "Final Observation Checklist" shall be completed by the Contractor. Any non-applicable items shall be marked "N/A." The completed form shall be submitted, indicating that all necessary items are complete and requesting a final observation within 10 days. The Contractor shall be notified of any uncompleted items within seven (7) days. A resubmittal of the form and a new final observation request by the Contractor is required if the form is returned and noted as incomplete.

END OF SECTION 22 0500

Project:_____ **Date Submitted:**_____

General Contractor:_____ **Date of Final Mechanical System:**_____
Mechanical Contractor:_____ **Observation Requested:**_____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

HVAC/PIPING

_____1. All plumbing fixtures are set, sealed and cleaned.

_____2. All domestic pipe systems are insulated.

_____3. All pipe systems are identified with specified labels and directional arrows.

_____4. Floor sinks and drain grates are cleaned and debris removed.

_____5. Valve tags are installed.

_____6. Special equipment (water softeners, water heaters, piping systems, etc.) have been checked and put into service.

_____7. Medical gas systems have been checked and certified.

_____8. Special piping systems have been cleaned and pressure tested.

_____	Process Piping	_____	Nitrogen
_____	Compressed Air	_____	Vacuum
_____	Natural Gas	_____	Argon
_____	Other	_____	Medical Gas
		_____	Other

_____9. Limestone chips have been installed in acid dilution sumps.

_____10. Plumbing/piping connections have been completed to Owner furnished equipment and equipment furnished by other Contractors/Sub-Contractors.

_____11. Exterior wall hydrants have been cleaned.

_____12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.

_____13. Drains and relief lines from plumbing equipment have been installed and secured in a proper manner.

_____14. All plumbing equipment and areas of equipment have been cleaned and debris removed.

_____15. All plumbing equipment required by the Specifications has been identified and/or numbered.

_____16. Domestic water systems sterilization has been completed.

_____17. Strainers/suction diffusers have been cleaned.
_____18. Backflow preventers have been tested.

_____19. Air has been vented from all systems.

_____20. Ethylene glycol system has been charged with correct mixture and tested.

_____21. Water systems have been cleaned (X) and pressure tested (P).

_____	Non-potable Water	_____	Domestic Hot Water
_____	Domestic Cold Water	_____	Acid Waste and Vent
_____	Sanitary Sewer & Vent	_____	Roof and Overflow Drains
_____	Other (list)		

_____22. PRV's have been adjusted (water, gasses).

PLUMBING EQUIPMENT

_____1. All pump shafts and couplings have been aligned.

_____2. Boilers and domestic water heaters have been fired and tested.

_____3. All plumbing equipment has been lubricated.

_____4. Plumbing equipment has been labeled in accordance with the specifications.

_____5. "HAZARDOUS AREA" signs installed where applicable.

_____6. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

GENERAL ITEMS

The following specified items have been submitted:

_____1. Record drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 22 0500).

_____4. Test kits furnished to Owner.

_____ Flow Measuring Devices
_____ Flow Balance Valves
_____ Flow Control Devices

_____5. Control schematics and sequence of operation.

_____6. Plumbing equipment and lubrication, valve, charts have been provided to Owner's Representative.

END CHECKLIST

DIVISION 22 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.**
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:
Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____
_____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain: _____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
   _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
   _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
   _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
   _____
9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted _____ Not Accepted: _____ Received too Late: _____
By: _____ Date: _____
Remarks: _____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2:_____

Date: _____

SECTION 22 0503 - TRENCHING AND BACKFILLING FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 22.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplementary Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 TRENCHING AND BACKFILLING

A. General Excavation: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not required or suitable for backfill shall be removed and wasted. Berming and grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as required for the protection of the work and for the safety of personnel.

B. Trench Excavation: Trenches shall be of adequate width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable and safe for workmen. The bottom of the trenches shall be accurately graded and bedded to provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the

trench bottom has been graded, and bedded in order that the pipe rests upon the prepared bottom for as nearly its full length as practicable. Care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated on the drawings or specified. Overdepths in the rock and common excavation shall be backfilled with coarse sand, fine gravel, or otherwise suitable material. Whenever wet or otherwise unstable soil that is incapable of properly supporting

the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable materials, as hereinafter specified.

C. The Contractor shall move trucks and equipment on prescribed roads and keep the roads free from mud, dirt and spillage.

D. If additional material is needed for fill on the project, it shall be furnished by the Contractor.

E. Bracing and Bulkheading: In all excavation work the Contractor shall provide necessary underpinning, bracing, or bulkheading to safeguard the work, the present structures, workmen, the public, and the property, and shall assume all responsibility in connection therewith.

F. Backfilling: The trenches shall not be backfilled until all required pressure tests are performed and until the utilities as installed conform to the requirements specified. The trenches shall be carefully backfilled with materials approved for backfilling; free from large clods of earth or stones. The entire depth of trench shall be backfilled in layers, and each layer shall be spread evenly, wetted to optimum moisture and thoroughly mixed to uniform consistency and compacted to the required maximum density obtainable as the same soil, as determined by ASTM D698.

G. All imported fill required under this section will be furnished by the Contractor. Imported fill will be base course material approved for use by the State Highway Department.

H. Fill material shall be free from trash, lumber or any type of debris which may be detrimental to producing the required density in the fill.

I. The earth beneath all sidewalks and concrete slabs shall be backfilled and compacted to at least 8" below any gravel or sub-base material before the placement of gravel or other base material and shall be coordinated with requirements contained within Division 2.

J. All piping not encased in concrete shall be bedded in sand or fine gravel, without rocks or other foreign material. Bedding material shall be placed around the pipe in accordance with manufacturer’s recommendations. The bedding material shall be distributed around pipe to assure full consolidation.

K. In grass and planted areas, the Contractor shall backfill his excavation to approximately 8" below finished grade. Contractor shall coordinate backfill requirements contained in Division 2.

L. The Contractor shall protect from damage all existing underground utilities and utility tunnels indicated on the Contract Drawings. Any damage to such existing utilities or utility tunnels shall be repaired by the Contractor without additional costs to the Owner.

M. Provide density test for trench, backfill in accordance with Division 2 requirements.

END OF SECTION 22 0503

SECTION 22 0504 - PIPE AND PIPE FITTINGS FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

END OF SECTION 22 0504

SECTION 22 0505 - PIPING SPECIALTIES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0523, Valves for Plumbing.

D. Section 22 0700, Plumbing Insulation.

E. Section 22 0549, Plumbing and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. The Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, Piping Specialties.

PART 3 - EXECUTION

See Division 23, Section 23 0505, Piping Specialties.

END OF SECTION 22 0505

SECTION 22 0523 - VALVES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Division 21 for Fire Suppression System.

D. Division 22 for Plumbing.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Ball valves shall be utilized in lieu of gate valves and globe valves for all plumbing systems for sizes 2" and smaller.

D. All valves furnish under Division 22 and 23 of the same type shall be products of a single manufacturer [unless otherwise approved by Owner's Representative.

E. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

PART 2 - PRODUCTS

See Division 23, Section 23 0523 - Valves, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0523 - Valves, for applicable requirements.

END OF SECTION 22 0523

SECTION 22 0549 - PLUMBING AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Division 25, Facility Management System.

C. Division 26 for Electrical.

D. Division 28 for Electronic Safety and Security.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 22 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 22	Div. 22	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div.**25**
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. **25**
Variable Frequency Drives (VFD's)		Div. 22	Div. 22	Div. 26	Div. **25**
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 22	Div. 22	Div. 26	Div. **25**
Boilers & Domestic Water Heaters		Div. 22	Div. 22	Div. 26	Div. **25**
Pressure Booster Pump Systems		Div. 22	Div. 22	Div. 26	Div. **25**
Water Softeners & Other Process Water Equipment		Div. 22	Div. 22	Div. 26	N/A
Facility Management System (FMS) for Automatic Control and/or Monitoring of Plumbing System & Equipment	(2)	Div. 23	Div. 23	Div. 26	Div. **25**
Medical Gas System - Alarm Panels, Sensors, Pressure Switches	(3)	Div. 22	Div. 22	Div. 26	Div. 22

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall coordinate with Division 23, FMS Contractor as required to provide 120 VAC power to each mechanical space and the central plant as necessary for the FMS and as shown on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 22 indicates the plumbing contractor or their designated representative including equipment suppliers, sub-contractors, etc. Division 25 indicates the Integrated Automation Contractor.

END OF SECTION 22 0549

SECTION 22 0700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. The Midwest Insulation Contractors Association and Industrial Insulation Standards, Latest Edition, shall be utilized as a standard for the work provided under this specification.

C. Materials shall conform to applicable ASTM standards.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

1.3 SCOPE

A. All condensate pipe and fittings, domestic hot water pipe including and circulating hot water, interior roof drains including roof drain bowls, interior overflow roof drains including overflow roof drain bowls, domestic cold water including soft cold water piping, water piping located outdoors exposed to ambient freezing conditions.

B. Equipment covering, including heat exchangers, storage tanks, and pumps.

C. Underground Piping Systems.

D. Plastic Piping Systems.

1.4 FITTINGS

A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.

B. Unions, flanges and valves on hot water, will not require insulation.

1.5 TESTING

A. All piping shall be tested in accordance with the applicable Specification Sections, before any insulation is applied.

PART 2 - PRODUCTS

2.1 INSULATION

A. Insulation shall be as manufactured by Owens-Corning Fiberglas, Knauf, CertainTeed, Johns Manville, or Armstrong, or equivalent, and shall be equal to that specified below. Insulation and all materials on the interior and exterior surfaces of ducts, pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. All insulation materials used for valves and fittings shall have the same ratings as the pipe insulation. Information must be submitted by means of manufacturer's literature showing that the proposed materials conform to above specification without exception.

B. Fiberglass pipe insulation shall be rigid molded and non-combustible with 'K' factor of 0.23 at 75°F. Jacket shall be all service (ASJ) vapor barrier jacket with white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self sealing longitudinal laps and butt strips. Johns Manville 'Micro-Lok' or equivalent.

C. Hydros Calcium Silicate insulation shall be rigid molded, non-combustible per ASTME 136, conforming to ASTM 533, asbestos-free with 'K' factor of 0.40 at 300°F., maximum service temperature 1200°F., compression strength (block) minimum of 200 PSI to produce 5% compression at 1-1/2" thickness. Johns Manville 'Thermo-12 Gold' or equivalent.

D. Fiberglass rigid board insulation for equipment shall conform to ASTM C612 with 'K' factor of 0.23 at 75°F, R=8.0 minimum, 3.0 pound per cubic foot density. Provide vapor barrier jacket (FSK) with aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and outward clinched expanded staples and vapor barrier mastic. Johns Manville 'Spin-Glas' or equivalent.

E. Elastomeric foam insulation for piping and equipment shall be flexible, cellular, molded or sheet, conforming to ASTM C534, with 'K' factor of 0.28 at 75°F., maximum service temperature of 220°F., maximum flame spread rating of 25 and maximum smoke development rating of 50 (3/4" thickness and less). Connections shall be made using manufacturer's approved waterproof vapor barrier retarder adhesive. Provide outdoor U.V. protective coating on all insulation exposed to ambient conditions.

2.2 FITTINGS

A. Valves and fittings, where required to be insulated, shall be covered with the same insulation material and thickness as specified for the pipe insulation and finished with PVC covers.

B. Valves and fittings with systems specified to be covered with metal or canvas, or polyvinyl chloride (PVC) jacket shall be covered with material to match piping system jacketing.

C. Polyvinyl chloride (PVC) preformed fitting covers with fiberglass inserts shall be used on valves and fittings, except where metal or canvas jacket is required for piping system. PVC fitting covers shall be Zeston 2000 or equivalent, gloss white and shall have a composite fire and smoke hazard rating not exceeding; flame spread - 25; smoke development - 50.

Connections shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.3 METAL JACKETING

A. Metal jacket shall be 0.010-inch smooth Type 304 stainless steel, smooth. Provide moisture barrier lining for service temperatures 60°F and less, except where applied over insulation with All Service (ASJ) vapor barrier jacket. Stainless steel jacket shall be installed where specified herein or otherwise indicated on the drawings.

2.4 PVC JACKETING

A. PVC jacketing shall be Zeston 2000 or equivalent, gloss white, 0.020 inch thickness, minimum, and shall have a composite fire and smoke hazard rating not exceeding; flame spread -25; smoke development -50. Connection shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.5 CANVAS JACKETING

A. Canvas jacketing shall be UL listed fabric, six ounce per square yard, plain weave cotton, treated with fire retardant lagging adhesive.

2.6 PIPE HANGERS AND SUPPORTS

A. See Specification Section 22 0504 for requirements associated with hangers and supports for piping systems.

B. All insulated piping systems shall be provided with individual hangers sized to encircle the insulation. Hangers for domestic cold water and roof drains may be installed under the insulation, provided that the vapor barrier system for cold piping and the hanger rods are protected from the formation of condensation by application of a heavy coating of vapor barrier mastic material.

C. Insulated piping supported by means of trapeze hangers or roller type hangers shall not rest directly on the hanger or support.

D. The insulation at hangers, trapezes and supports shall be protected by means of galvanized steel insulation half diameter support shields. Provide insulation insert between support shield and piping for piping size 1-1/2" and larger. Insulation inserts shall be heavy density calcium silicate molded insulation. Insulation inserts shall be the following minimum lengths. Factory fabricated thermal pipe shield as manufactured by Pipe Shields, Inc., and specified in Section 22 0504, may be used at Contractor's option.

Pipe Size, In.	Insert Length
1-1/2" to 2-1/2"	10" Long
3" to 6"	12" Long
8" to 10"	16" Long
12" and larger	22" Long

2.7 PIPE SLEEVES

A. See Specification Section 22 0504 for requirements associated with pipe sleeves for piping penetrations for building walls and frames.

B. Pipe sleeves shall be provided at penetrations through concrete and masonry construction and at fire rated and smoke rated walls and penetrations when required to comply with UL approved penetration assembly. Insulated piping passing through fire walls and smoke walls shall be provided with UL approved fire safing insulation to match the required insulation thickness and the space between the piping penetration and the adjacent wall construction shall be sealed air tight with UL approved fireproof caulking material. Pipe penetration arrangement and installation requirements shall match the applicable UL approved penetration assembly details.

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER PIPING

A. Domestic hot water piping with operating temperatures of 140°F and less, including and recirculating hot water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be finished with PVC fitting covers.

B. Insulation thickness for domestic and service water systems operating in excess of 140°F, shall be 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ) for piping 3/4" through 3" size and 1-1/2" thick for piping 4" and larger. Fittings shall be finished with PVC fitting covers.

C. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.2 DOMESTIC COLD WATER AND ROOF DRAINS

A. Domestic cold water piping including soft cold water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Services Jacket (ASJ). Fittings shall be finished with PVC fitting covers.

B. Roof drain bowls and horizontal roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

C. Overflow roof drain bowls and horizontal overflow roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

D. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.3 HANDICAP LAVATORY AND SINKS

A. Domestic hot and cold water piping and P-traps exposed below handicapped lavatories and sinks shall be insulated with HANDI LAV-GUARD insulation kits which satisfy ANSI A117.1

requirements. Insulation shall have a flexible vinyl finish which protects against burning and cushions impact.

B. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches.

3.4 PLASTIC PIPING SYSTEMS

A. Plastic piping systems, including but not limited to polypropylene/CPVC, RO/DI piping, acid waste, vent piping and PVC piping, installed within building return air plenums shall be insulated with 1/2" thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be insulated with preformed insulation fittings or, where preformed fittings are unavailable, neatly insulated with fiberglass duct wrap with white vinyl jacket.

B. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.5 SUCTION DIFFUSERS AND PUMP IMPELLER HOUSING

A. Suction diffusers and pump impeller housing on plumbing domestic hot water pumps except fractional horsepower hot water recirculating pump located at domestic water heaters shall be insulated with minimum 1-1/2" thickness fiberglass board with vapor barrier jacket and cover with metal jacket. Fill voids in fiberglass board housing with fiberglass batt insulation. Insulation housing shall be removable for pump maintenance without damaging the insulation and provide removable access cover for suction diffuser strainer casing cover.

3.6 METAL JACKETING

A. Metal jacketing shall be installed on all field insulated plumbing equipment and on plumbing piping systems exposed within the mechanical equipment spaces, that are installed exposed below 8 feet above the floor, on outdoor insulated piping, inside accessible tunnels, and where noted on the drawings.

B. The jacketing shall be applied with joints overlapped 2" and located to shed water. Joints and seams shall be caulked with an approved weatherproof caulking when located outdoors. The insulation shall be banded 12" on centers or screwed in place 3" on centers.

C. Fittings and valves shall have insulation covered with metal jacket, as specified herein. Fittings and valves on exterior piping and ductwork shall be covered with metal jacketing to match pipe and duct covers.

3.7 PVC JACKETING

A. PVC jacketing shall be installed on all field insulated plumbing equipment and on all piping systems exposed within the mechanical equipment spaces, that are installed below 8 feet above the floor, where exposed to physical damage, and where noted on the drawings and specifications, except where metal or canvas jacketing is required.

B. Jacketing shall be secured in place in an approved manner by means of tacks and pressure sensitive tape.

C. Fittings and valves shall have insulation covered with PVC pre-molded PVC fittings to match jacketing, as specified below.

D. PVC jacketing shall not be permitted for use on exterior piping systems.

3.8 CANVAS JACKETING

A. Canvas jacketing shall be installed on all field insulated plumbing equipment and on all piping systems where noted on the drawings and specifications, except where metal or PVC jacketing is required.

B. Canvas jacket shall be adhered in place with fire retardant lagging adhesive and coating, to form a wrinkle free smooth continuous surface.

3.9 TERMINATION OF INSULATION

A. The termination of all insulation on pipes, at uninsulated valve connections, or unions, flexible connections, etc., shall be beveled and finished.

3.10 FACTORY INSULATED EQUIPMENT

A. Domestic water storage tanks, heat exchangers, and other equipment as specified in the equipment schedules on the drawings shall be factory insulated.

3.11 VICTAULIC COUPLINGS

A. Where Victaulic type couplings or similar piping systems are used, all couplings shall be insulated with insulation materials and thickness equal to the piping system. Insulation of couplings shall be as specified herein for fittings.

3.12 VESSELS, TANKS, AND EQUIPMENT

A. Insulate hot vessels, tank, and equipment, including shell and tube heat exchangers, storage tanks, plate and frame heat exchangers, etc., with 1" thickness, 3 pound density fiberglass insulation for surface temperatures from 40°F to 60°F, 2" thickness, 3 pound density fiberglass insulation for surface temperatures from 60°F to 400°F, and 4" thickness, calcium silicate insulation for surface temperatures in excess of 400°F to 1200°F. Insulation board shall be scored, beveled, or mitered to provide tight joints and shall be secured in place by mechanical pin and clip fasteners and insulation bonding adhesive applied to underside surfaces or with bands. All joints, cracks, seams and voids shall be filled with insulation bedding compound and finished to smooth surface, provide corner beads to protect edges of insulation. Cover insulation with metal jacket as specified herein. Bevel insulation away from all flanges, nameplates, and access fittings. Provide removable and re-usable insulation cover for all access fittings and manhole covers.

B. Plate and frame heat exchangers shall be provided with a removable and re-usable insulation cover consisting of rigid insulation secured to galvanized steel metal frame-work and covered with metal jacket as specified herein.

3.13 HEAT TRACED PIPING

A. All piping installed outdoors subject to freezing which is provided with heat tracing system as specified in Section 22 0505, including domestic water piping exposed to freezing conditions, make-up water piping to Division 22 and Division 23 equipment, including valves and fittings, shall be insulated with fiberglass sectional pipe insulation, as specified for chilled water piping, and finished with metal jacket. Oversize insulation as required to accommodate electric heat tracing system. Waterproof metal jacket joints and seams with silicone caulking.

3.14 UNDERGROUND PIPING

A. Underground domestic hot water piping shall be insulated using pre-insulated piping and protective covering suitable for underground use, as specified in Section 23 2119.

END OF SECTION 22 0700

SECTION 22 1100 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead. Solder shall be 95/5 tin antimony, alloy Sb5, conforming to FS QQ-S-571 and NSF 61.

1.2 RELATED SECTIONS

Section 22 0500, Common Work Requirements for Plumbing
Section 22 0504, Pipe and Pipe Fittings for Plumbing.
Section 22 0505, Piping Specialties for Plumbing.
Section 22 0523, Valves for Plumbing.
Section 22 0700, Plumbing Insulation.
Division 25, Facility Management System.
Section 22 6801 and Division 33 for Outside Utilities.

1.3 SCOPE

A. A complete domestic cold water, hot water, recirculating hot water, and make-up water system including water heaters, pumps, thermal expansion tanks, backflow protection, shock absorbers, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 for site utility drawings and specifications.

PART 2 - PRODUCTS

2.1 PIPING

A. Domestic water piping below grade or slab-on-grade shall be Type L soft copper, ASTM B88. Copper piping 2" and smaller shall be soft tubing and 2-1/2" thru 4" shall be either soft tubing or hard pipe. Domestic water piping 6" and larger including soft water piping below grade

within the building and to a point approximately 5'-0" from the building shall be ductile iron pressure pipe, minimum 150 PSIG working pressure with mechanical joints. Wrap all underground copper pipe and fittings with minimum 20 mil polyethylene with minimum 50% overlay, provide for taping.

B. Domestic water piping above grade within the building 4" and smaller shall be Type L hard drawn copper, ASTM B88. Domestic water piping including soft water piping, larger than 4" shall be copper as specified.

C. Proper insulating fittings, as specified in Section 22 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

A. Fittings for copper piping shall be wrought copper or cast brass conforming to ANSI B16.22 and B16.23, with 95-5 solder joints, as specified in Section 22 0504.

B. Mechanically formed tee connections and couplings for copper piping system as specified in Section 22 0504, may be utilized where approved.

C. Fittings for galvanized steel pipe shall be screwed Class 150, standard galvanized malleable iron conforming to ANSI B16.3.

D. Fittings for ductile iron pipe shall be flanged or mechanical joint conforming to ANSI/AWWA C110 and C111, Class 250 minimum, cement lined, with bituminous coating.

2.3 FLANGES

A. Flanges for copper piping systems shall be Class 150 wrought copper or cast brass conforming to ANSI B16.24.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Flanges for galvanized steel piping system shall be galvanized cast or malleable iron Class 125, standard threaded plain face companion flanges for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 JOINTS

A. Joints in copper piping system shall be made using approved "lead-free" solder and flux as described herein and approved by all applicable codes and regulations. Surfaces to be soldered shall be cleaned bright by manual or mechanical means.

B. All joints shall be properly fluxed with a non-corrosive "lead-free" type flux manufactured to approved standards, Federal Specification QQ-S-517. Joints for copper piping systems for cold water 3" and smaller and hot water 2" and smaller shall be made using composition 95-5 tin-antimony solder. Composition 15% silver solder shall be used for all other piping sizes and for all underground joints.

2.5 SHOCK ABSORBERS

A. Furnish and install factory sealed shock absorbers conforming to Federal Specification WW-P-541 at locations shown on the drawings and/or as outlined by Plumbing Drainage Institute Standard WH-201. Josam, Precision, Jay R. Smith, Wade, Watts, Zurn or equivalent.

2.6 DOMESTIC HOT WATER GENERATING EQUIPMENT

A. Hot water generators and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings.

B. Furnish and install approved expansion tank on cold water make-up supply to hot water generating equipment as recommended by manufacturer or as shown on the drawings and specified in the plumbing equipment and fixture schedule on the drawings, Amtrol, Wilkins, or approved equal.

C. The Contractor shall provide the services of a qualified factory-trained representative to supervise hot water generation system start-up and instruct the Owner’s operating personnel for a minimum of eight (8) hours. A full one (1) year service warranty, including all parts and labor, shall be provided by the Contractor.

2.7 VALVES

A. Valves other than automatic control valves are specified in Section 22 0523, Valves.

B. Automatic control valves shall be as specified in Division25, Facility Management System, except for automatic control valves furnished as a part of equipment packages, including hot water generating equipment, as specified on the equipment schedule.

2.8 PUMPS

A. Pumps shall be of the type and capacity listed in the equipment schedule. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All base mounted pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping. All pumps for potable water applications shall have bronze or stainless steel body and trim.

B. Domestic water inline re-circulating pumps shall be as specified on the drawings and as manufactured by Armstrong, Bell & Gossett, Taco, Thrush, or equivalent.

C. Manufacturer shall furnish a full one (1) year warranty, including all parts and labor for the water pressure booster pumping system.

2.9 WATER METER

See Division 33 for water meters.
See Division 25, Facility Management System, for plumbing, meters and instrumentation.

2.10 BACKFLOW PROTECTION

A. All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system.

B. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.

C. Reduced pressure backflow preventer assembly shall be furnished and installed by the Contractor. Backflow preventer size and arrangement shall be as indicated on the drawings, and shall be as manufactured by Febco, Hersey, Beeco, Watts, Wilkins, or equivalent. All costs, fees, and permits required shall be secured and paid for by the Contractor, unless otherwise indicated.

D. See Section 22 6801 for backflow protection.

E. See Section 23 0504 for backflow preventer required for make-up water connections to HVAC systems.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for plumbing.

B. Insulating Fittings: Insulating unions shall be furnished and installed at all connections between dissimilar metals.

C. Valves: Each water service main, branch main and branch to a group of two or more fixtures shall be valved. Stop valves shall be as specified under fixtures.

D. Flexible Connections: If the Contractor uses a pipe material other than copper to connect to the City water main, provide mechanical joints at the connection point and also either a swing joint or expansion joint at a point 5 ft. outside the building to prevent failure of piping caused by

differential settling of building and piping systems. The expansion joint material shall be suitable for domestic water usage and compatible with the sterilization chemicals.

3.2 STERILIZATION

A. All new water piping shall be charged with a chlorine solution containing not less than 50 PPM available chlorine. The solution shall remain in the piping for a period of 24 hours, during which time valves shall be opened and closed to permit a small flow of the solution. At the end of 24 hours, the solution shall be tested and must contain a residual of at least 5-10 PPM chlorine. The system shall then be drained and flushed to provide satisfactory potable water before final connection is made to the existing distribution system.

B. The Contractor shall submit a sample of the water, after sterilization and flushing for testing by an approved laboratory. A copy of the acceptable test report shall be submitted to the Architect prior to substantial completion.

3.3 BACKFLOW PROTECTION

A. Protection: All plumbing fixtures, faucets with hose connections, and all other equipment having plumbing connections shall have their water supplies protected against back-siphonage.

B. Testing: Arrange for testing backflow devices as required by the local health authorities.

3.4 TESTS

A. All water piping, hot and cold, shall be made tight under a hydrostatic test pressure of 150 lbs. per square inch and maintained without pressure loss for a minimum of four (4) hours. No caulking of joints will be permitted. Any joint found to leak under this test shall be broken, remade and a new test applied.

END OF SECTION 22 1100

SECTION 22 1123 - FACILITY NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Supplemental General Conditions.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Division 25, Facility Management System.

F. Division 33 and Division 22 for onsite utilities.

1.3 SCOPE

A. Complete building natural gas piping system including meters, regulators, and miscellaneous accessories. This section shall include all work within the building.

PART 2 - PRODUCTS

2.1 PIPING

A. Above ground pipe used for the installation, extension, alteration, and/or repair of any gas piping system shall be black steel pipe ASTM A53 Grade A or B, ERW or BW, standard wall, Schedule 40.

B. All underground gas piping shall be steel or polyethylene plastic piping as specified in Section 22 0523, Valves for Plumbing. All underground steel piping and fittings shall be protected from corrosion by approved coatings or wrapping materials as specified in Section 22 0504, Pipe and Pipe Fittings for Plumbing, and Section 22 6801, Outside Utilities, Plumbing.

2.2 FITTINGS

A. Fittings for steel piping 2" and smaller shall be either screwed or welded. Screwed fittings shall be Class 150 standard black malleable iron conforming to ANSI B16.3. Weld fittings shall be either standard weight steel butt-weld fittings conforming to ANSI B16.9, or forged steel socket-weld fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.

B. Fittings for steel piping 2-1/2" and larger shall be standard weight steel butt-weld fittings conforming to ANSI B16.9.

2.3 FLANGES

A. Flanges for steel piping system shall be forged steel, weld neck, or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Where specifically required by the application, black cast iron Class 125 standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick full face non-asbestos material suitable for the temperatures and pressure application.

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 VALVES

A. Valves shall be as specified in Section 22 0523, Valves for Plumbing.

B. Valves used in conjunction with gas piping shall be approved for the required service.

2.5 PIPING SUPPORTS

A. Natural gas piping installed on the building roof shall be supported by means of piping supports, especially designed to absorb thermal expansion and contraction of piping installed on built up and single ply membrane roofs. Wood blocks are not acceptable. Four inch and smaller gas piping shall be mounted on Erico Pyramid pipe supports or equivalent, pipe supports with a total weight not to exceed 100 pounds per pipe stand. Larger piping, and all piping requiring roller bearing action for pipe expansion, shall be mounted on Erico Pyramid RPS-H or equivalent, with a total weight not to exceed 1500 pounds per pipe collar support. Pipe support spacing shall be as recommended by manufacturer and as required by Code.

B. Piping hangers and supports shall be in accordance with Section 22 0504, Pipe and Pipe Fittings for Plumbing.

2.6 PAINTING

A. All natural gas piping installed outside the building exposed to the weather [and/or exposed to view] shall be field painted in accordance with the painting sections of this specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including Uniform Plumbing Code and Uniform Mechanical Code, and NFPA No. 54, National Fuel Gas code.

C. No gas piping shall be installed in or on the ground under any building or structure, and all exposed gas piping shall be at least 6-inches above grade. Ferrous gas piping installed underground in exterior locations shall be protected for corrosion as specified herein and in Section 22 0504, Pipe and Pipe Fittings for Plumbing.

D. Gas piping supplying the building or facility shall be provided with a shut-off valve located outside the building and readily accessible. Where gas piping supplies multiple buildings or facilities, each building shall be provided with a shut-off valve as described herein.

3.2 EQUIPMENT AND APPLIANCE CONNECTIONS

All gas fired equipment and appliances shall be connected to the gas piping system in an approved manner and shall be furnished with a shut-off valve installed ahead of the unit. Connections shall in no case be less than the unit inlet connection size and shall be rigidly connected, except as otherwise shown on the drawings and allowed by codes and regulations.

3.3 DRIPS

A. Accessible capped drip pockets shall be furnished at low points in piping system, connections to appliances and equipment, and other locations where condensation may tend to collect.

3.4 VENTS

A. All gas regulators and other required devices installed within the building shall be vented to the outside of the building in accordance with manufacturer's requirements, codes, and regulations.

3.5 TESTS

A. All gas piping shall be pressure tested using air, CO2, or nitrogen in accordance with the applicable codes and regulations, including Uniform Plumbing and Mechanical Code as adopted and interpreted by the City of Las Cruces and State of New Mexico, and NFPA No. 54.

END OF SECTION 22 1123

SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Special Provisions.

B. Furnish and install all concrete, grout, and other required materials to fill all blockouts and/or sleeves left open for this Contractor's convenience or for the installation of this work.

1.2 RELATED SECTIONS

Section 22 0500, Common Work Requirements for Plumbing.
Section 22 0504, Pipe and Pipe Fittings for Plumbing.
Section 22 0700, Plumbing Insulation.
Division 25, Facility Management System.

1.3 SCOPE

A. Complete soil, waste, and vent system, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 site utility drawings and specifications.

C. Plumbing equipment drains.

PART 2 - PRODUCTS

2.1 PIPING

A. Soil, waste, and vent piping below slab on grade shall be service weight cast iron no hub or bell and plain end pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards or polyvinyl chloride (PVC) sewer pipe, Schedule 40, conforming to ASTM D3034.

B. Soil, waste, and vent piping above grade shall be either service weight cast iron no hub or bell and plain end pipe, coated inside and outside, conforming to ASTM A-74 and 87 standards.

C. No-hub cast iron pipe shall conform to CISPI Standard 301 and shall be marked with CISPI Label.

D. Piping for pumped soil and waste systems from the discharge of the sump or sewage ejector pumps to the connection to the gravity flow drainage system shall be schedule 40 galvanized steel or Type L hard drawn copper pipe for above ground installation. When underground piping is required within

the building and to point approximately 5'-0" from the building perimeter, the underground piping shall be coated cast iron or ductile iron pressure pipe and fittings with joints blocked, braced, and/or strapped in an approved manner to prevent joint separation under pressure.

2.2 FITTINGS

A. Fittings for cast iron sanitary soil, waste and vent piping system shall be service weight or no-hub cast iron drainage pattern conforming to ASTM C564. Fittings shall be provided to match the required piping system.

B. No-Hub pipe fittings shall comply with CISPI Standard 301 and shall be marked with CISPI Label.

C. Fittings for PVC piping system shall be Schedule 40 drainage pattern, solvent cement type conforming to ASTM B-2855 or elastomeric seal type conforming to ASTM D-3212.

2.3 JOINTS

A. Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum, double seal compression-type molded neoprene gaskets conforming to ASTM C-564 Standards, and suitable for the class of pipe being jointed, with adhesive type joint lubricant, Tyler "LUBRI/FAST" or equivalent. No-hub coupling shall be minimum four (4) band type with neoprene gasket material conforming to ASTM C-564, and 0.008-inch minimum, Type 304 stainless steel shear ring. Couplings shall be Tyler "Wide Body", Huskey Series 4000, Clamp-All, Mission Heavy Weight, Ideal, or equivalent.

B. Joints for galvanized steel shall be threaded, made with approved joint compound.

C. Joints for copper shall be soldered using 95-5 composition tin-antimony solder with non-corrosive flux.

D. Joints for PVC piping system shall be either solvent cement type conforming to ASTM D-2855 or elastomeric seal type conforming to ASTM D-3212, except all joints above grade shall be solvent cement.

2.4 PLUMBING EQUIPMENT DRAINS

A. Equipment drain lines shall be either Schedule 40 galvanized steel pipe with galvanized malleable iron fittings or Type M copper tubing with wrought solder fittings. Provide a dielectric union at all connections between ferrous to copper materials.

2.5 DRAINS

A. Floor drains, floor sinks, and interceptors shall be Josam, Rockford, Jay R. Smith, Wade, Watts, Zurn, Mifab, or equivalent, as specified on the drawings, and compatible with the required piping systems.

B. Non water-based trap seal maintenance devices by Jay R. Smith Mfg. Co., Liquidbreaker – The Green Drain, SureSeal, and TrapGuard as specified on the drawings are approved.

2.6 TRAPS AND TAILPIECES

A. Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal to metal or metal to plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy to match P-trap. Furnish cast brass wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated. Underground P-traps shall be coated cast iron as required by the application.

B. Traps and associated trim shall be furnished by the plumbing fixture manufacturer as specified in Section 22 4000 and in the Fixture Schedule on the drawings, or shall be as manufactured by Dearborn, EBC, McGuire, T & S Brass, or equivalent.

2.7 CLEANOUTS

A. Cleanouts shall be as manufactured by Zurn, Jay R. Smith, Watts, Wade, or Josam, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter-bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and finished flush with the floor. Heavy duty cleanouts shall be Zurn Z-1474, with integral anchor flanges. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T-pattern, 90 degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z-1460-8 with polished stainless steel or chrome plated metal cover.

B. Cleanouts for acid resistant piping system shall be compatible material for the required piping system.

C. Install cover flush with grade (outside) to avoid tripping hazard.

2.8 MANHOLES

A. See Division 33, Outside Utilities, for manholes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties.

B. All soil, waste, and vent piping shall be properly graded and installed in strict accordance with all applicable codes and requirements.

C. Make all changes in direction of drainage piping by use of 45 degree wyes, long turn tee wyes, long sweep quarter bends, sixth, eighth or sixteenth bends. Short turn sanitary tees permissible on horizontal to vertical where space conditions require.

3.2 FLASHINGS

A. Flashing for piping through built-up roofing with lead flashing, weight of not less than four pounds per square foot, extending at least 12" in all directions under roofing and up pipe. Cap flash pipe and turn down inside 1" approximately. Run all pipes extending through roof prior to roof installation. Flashing shall be two-piece type, base and cap flashing.

B. Vinyl Flashing: As an option to lead flashing in vents through roof, the Contractor may use vinyl flashing, 20 mil thickness, ASTM C689-62 tear strength, 0.14 #/Ft. equal to Pasco Manufacturing Co., or equivalent. The flashing shall be installed in accordance with the manufacturer's recommendations.

C. Flash piping through the membrane roofing systems with premolded pipe seal elastomeric flashing and sealants that are compatible with EPDM single ply membrane. The flashing material and installation procedure shall be in accordance with the roofing manufacturer's recommendations.

3.3 DRAINS

A. All floor drains, trench drains, and floor sinks shall be installed with grates square with building lines and with the top of grates installed level with adjacent finished floor.

B. The Contractor shall extend drain lines from all equipment requiring drainage, relief valves, and drain pans to the nearest floor drain or floor sink, and shall terminate indirectly with a minimum clearance of one (1) inch or as otherwise required by applicable codes and standards. Relief valve drain lines shall be extended to the nearest floor drain and shall be equal in size to relief valve outlet port.

3.4 TESTS

A. The sanitary soil waste and vent system and condensate drain system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system

water test shall be applied to the drainage and vent systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.

B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than ten (10) feet of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

C. Piping for pumped drainage systems shall be pressure tested as specified in Section 22 1100 for water systems as a minimum pressure equal to the system working pressure.

END OF SECTION 22 1316

SECTION 22 1400 - FACILITY ROOF DRAINAGE

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions and Special Provisions.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0700, Plumbing Insulation.

D. Division 33 for onsite plumbing utilities.

1.3 SCOPE

A. A complete roof drainage and overflow roof drainage and area drainage system and associated miscellaneous accessories. This section shall include all work within the building and to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 site utility drawings and specifications.

PART 2 - PRODUCTS

2.1 PIPING

A. Pipe, fittings and couplings below grade or slab-on-grade shall be service weight cast iron no hub pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards.

B. Pipe, fittings and couplings above slab on grade shall be either service weight cast iron no hub pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards.

C. No-hub cast iron pipe shall conform to CISPI Standard 301 and shall be marked with CISPI Label.

D. All above and/or below ground cast iron pipe and/or fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute.

2.2 FITTINGS

A. Fittings for cast iron pipe shall be service weight or no-hub cast iron drainage pattern, conforming to ASTM C564, coated for underground installation.

2.3 JOINTS

A. Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead or oakum, or double seal compression-type molded neoprene gaskets conforming to ASTM C-564 Standards, and suitable for the class of pipe being jointed, with adhesive type joint lubricant, Tyler "LUBRI/FAST" or equivalent. No-hub couplings shall be minimum four (4) band type with neoprene gasket material, conforming to ASTM 564, and 0.008-inch minimum, Type 304 stainless steel shear ring. Couplings shall be Tyler "Wide Body," Husky Series 4000, Clamp-All, Mission Heavy Weight, Ideal, or equivalent.

2.4 DRAINS

A. Roof drains and overflow roof drains shall be Froet, J. R. Smith, Josam, Mifab, Sioux Chief, Wade, Watts, Zurn, or equivalent as specified on the drawings and compatible with the required piping system. Drains shall be suitable for the required building construction system and shall be furnished complete with all extensions, receptors, flashings, and accessories required for the complete water-proof installation.

B. Catch basins shall be provided in accordance with the details and specifications shown on the drawings.

2.5 CLEANOUTS

A. Cleanouts shall be as manufactured by Froet, J. R. Smith, Josam, Mifab, Sioux Chief, Wade, Watts, Zurn, or equivalent, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter-bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and finished flush with the floor. Heavy duty cleanouts shall be Zurn Z-1474, with integral anchor flanges. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T-pattern, 90-degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z-1460-8 with polished stainless steel or chrome plated metal cover.

2.6 ACCESSORIES

A. Refer to Section 22 1316, Sanitary Waste & Vent Piping, for roof flashing requirements.

2.7 MANHOLES

A. See Division 33 for manholes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Roof drainage and trench drainage piping shall be properly graded and installed in strict accordance with all applicable codes and requirements. All turns and fittings shall be supported same as for waste and vent piping as specified in Section 22 1300.

3.2 RENCH DRAINS

A. All area drains shall be installed with grates square with building lines, and with the top of grates installed level with the adjacent finish grade level.

3.3 TESTS

A. The roof drainage and trench drainage system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system water test shall be applied to the systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.

B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a ten (10) foot of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

END OF SECTION 22 1400

SECTION 22 1500 - COMPRESSED-AIR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes

1. Pipe fittings, valves, and accessories

1.2 SUBMITTALS

A. Submit the following in accordance with subcontract submittal procedures:

1. Manufacturer's catalog data
2. Manufacturer's installation instructions
3. Materials/Parts list
4. Operational and Maintenance data
5. Warranties
6. Certification of welders and qualified welding procedure per Section 01 4444 and 01 4455.
7. Welding Inspection Reports, as applicable.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 5 years' experience and having maintenance service based within 200 miles radius of installation.

B. Material and Installation: Conform to ASME B31.9, Building Services Piping for systems operating at pressure of 150 psig or less and at temperature of 200°F or less. For systems beyond above pressure and temperature limitations, conform to ASME B31.1, Power Piping unless supplying process air; then use B31.3. The design codes and pressure(s) for this installation are as follows: B31.3; 150 psig.

1.4 WARRANTIES

A. Provide a minimum of 1-year manufacturer's warranty, parts and labor, for air compressor system.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTION

A. Alternate products may be accepted; follow Section 01 2500, Substitution Procedures.

2.2 COPPER TUBING AND FITTINGS (up to 2 inches)

A. Tubing: Copper, hard drawn or annealed, ASTM B88, Type L

B. Fittings: Wrought copper, ASME B16.22

C. Joints: Solder, ASTM B32, Alloy Sb5 tin-antimony

2.3 STEEL PIPE AND FITTINGS (over 2 inches)

A. Pipe: Black steel, ASTM A53, Schedule 40

B. Fittings: Steel, ASTM A234, Grade WPB, Schedule 40, butt-welding type, ASME B16.9

C. Joints: Welded

2.4 VALVES

A. Gate Valves: MSS SP-80 Class 150, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends to suit piping.

B. Ball Valves: MSS SP-110 Class 150, bronze, chrome-plated brass ball, full port, teflon seats and stuffing box ring, lever handle, solder or threaded ends to suit piping.

C. Globe Valve: MSS SP-80 Class 150, bronze body, bronze trim, solder or threaded ends to suit piping.

D. Swing Check Valve: MSS SP-80 Class 150, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends to suit piping.

2.5 STRAINER

A. “Y” type, Class 150, 20 mesh stainless steel perforated screen, bronze] cast iron body, with blowoff gate valve and plug, solder or threaded ends to suit piping.

2.6 UNIONS AND FLANGES

A. Unions

1. Ferrous Pipe: ASME B16.39, Class 150, malleable iron, threaded unions.

2. Copper Tube and Pipe: ASME B16.22, Class 150, bronze unions with soldered joints.

B. Dielectric Unions

1. Union with galvanized or plated steel threaded end, copper solder end, water-impervious isolation barrier.

C. Flanges (N/A to copper)

1. Forged carbon steel, ASTM A105, Class 150

2.7 FLEXIBLE CONNECTOR

A. Manufacturer: Flex-Hose, Pumpsaver Connectors.

B. Braided bronze or stainless steel flexible connector with corrugated metal hose, minimum working pressure 200 psi at 70 degree F, minimum temperature rating 400 degree F, with solder ends to suit piping.

2.8 PRESSURE GAUGE

A. Manufacturer: Ashcroft, Type 1009.

B. ASME B40.100, Grade 1A, minimum 2 1/2 inch dial, 1/4 inch NPT brass bottom connection, maximum plus or minus 1 percent full scale accuracy, stainless steel case, phosphor bronze bourdon tube, and isolation valve.

1. Range: 0-150 psi or as specified on drawings.
2. Cock Valve: 1/4 inch brass plug, 250 psi working pressure valve. Manufacturer: Anderson Metals, PAC-56NB, Part No. 138-00110.

2.9 PRESSURE REGULATING VALVE

A. Manufacturer: Watts, No. R119 Series

B. Reduced pressure type, range 0-125 psig, diaphragm operated, relieving spring adjustment mechanism, rated at 300 psig maximum, temperature range 40 - 120 degrees F.

2.10 SAFETY VALVE

A. Manufacturer: Kunkle Model 6010.

B. Safety valve for air service, side outlet, full nozzle design, bronze body, brass and bronze trim, pressure range 15-250 psig, temperature range minus 60 to 406 degrees F, NPT ends, built and tested to ASME Section VIII, Division 1 Pressure Code, “UV” stamped.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install compressor unit on concrete housekeeping pad.

B. Install compressor unit on vibration isolators. Level and bolt in place. Refer to Section 22 0548, Vibration and Seismic Controls for Plumbing Piping and Equipment.

C. Route condensate drains to nearest floor drain.

D. Provide drain valves at low points of piping system.

E. Install take-offs to outlets from top of main, with shutoff valve after take-off. Slope take-off piping to outlets.

F. Install compressed air couplings, female quick connectors, and pressure gages where branch outlets are indicated and as indicated on Drawings.

G. Labeling: Refer to Section 22 0554, Identification for Plumbing, HVAC, and Fire Piping and Equipment.

H. Pressure Testing: Refer to Section 22 0813, Testing Piping Systems.

I. Cap or seal ends of piping when not connected to mechanical equipment to ensure contamination by foreign material does not occur.

END OF SECTION 22 1500

SECTION 22 4000 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 01 3515, LEED Certification Procedures.

B. Section 22 0500, Common Work Requirements for Plumbing.

C. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

D. Section 22 1100, Domestic Water Piping.

E. Section 22 1316, Sanitary Waste and Vent Piping.

PART 2 - PRODUCTS

2.1 FIXTURES AND EQUIPMENT

A. Vitreous china and enameled cast iron fixtures by American Standard, Kohler, Sloan, Zurn, Mansfield, Toto, or equivalent as listed and described in the plumbing fixture schedule on the drawings. All vitreous china and enameled cast iron fixtures shall be white, unless otherwise indicated on the drawings. The material used for plumbing fixtures shall be of non-absorptive, acid-resistant vitreous china, enameled cast iron or stainless steel, and free from all imperfections. Each water service main, branch main, riser and branch to a group of fixtures shall be valved or as otherwise shown on the drawings to provide more stringent requirements. Stop valves shall be provided at each fixture. One piece chrome plated escutcheons shall be installed on all water piping and trap connections at walls or base cabinets. All exposed connecting piping and material shall be chrome plated.

B. Handicap accessible lavatories and counter mounted sinks shall have exposed supply and waste services insulated with rigid, molded insulation kits as manufactured by T.C.I. "Skal-Gard", Brocar "Trap Wrap", True-Bro "Handi Lav-Guard", McGuire "Prowrap", or equivalent. Provide off-set tail piece fittings on all handicap accessible laboratories and sinks as required.

C. Flush valves shall be low water consumption type as specified on drawings. Valves shall be diaphragm or piston type, with metal oscillating non-hold open handle, screw driver back check angle stop assembly with cap, adjustable tailpiece, vacuum breaker flush connection, and spud couplings as required for wall and fixture rough-in. Exposed flush valves shall be fully chrome plated, with chrome plated supply pipe cover. Flush valves shall be Delany, Sloan Royal, Sloan Regal, Zurn, American Standard, Toto, or equivalent.

D. Closet seats shall be furnished for water closets as specified on the Plumbing Fixture Schedule on the drawings. Closet seats shall be white unless otherwise required to match water closet. All closet seats shall be of smooth non-absorbent material and shall be properly sized for the water closet bowl type. All closet seats for fixtures for public use shall be open-front type without cover. Water closet seats provided for handicapped fixtures shall meet all handicapped requirements. Hinges, posts, nuts, and pintles shall be of a 300 series stainless steel construction. Water closet seats shall be furnished by the plumbing fixture manufacturer as specified on the Fixture Schedule on the drawings, or shall be as manufactured by Bemis, Beneke, Centoco, Church, Olsonite, Sperzel, or equivalent.

E. Floor mounted mop sinks shall be as specified on the Plumbing Fixture Schedule on the drawings, molded stone or terrazzo, size and arrangement as shown on the drawings, as manufactured by Acorn, Centoco, Designer’s Choice, Fiat, Mustee, Stern-Williams, Zurn, or equivalent.

F. Stainless steel sinks shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Kohler, American Standard, Elkay, Just, Advance Tabco, Moen, Intersan, or equivalent. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches. All sink basins shall have a center-rear outlet unless noted otherwise.

G. Electric water coolers (EWC) and drinking fountains shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Acorn Aqua, Elkay, Guardian, Halsey, Haws, Murdock, Oasis, Sunroc, Taylor or equivalent.

H. Hose bibbs and wall hydrants shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Zurn, Jay R. Smith, Wade, Woodford, Acorn, Chicago, T&S Brass, Watts, Prier, or equivalent. Handles, if specified shall be constructed of metal or brass and finished to match valve unit.

I. Shower valves and mixing valves shall be as specified on the Plumbing Fixture Schedule on the drawings, and as manufactured by Powers, Leonard, Lawler, Speakman, Symmons, Bradley, or equivalent.

J. Emergency fixtures including showers and eyewash shall be as specified on the Plumbing Fixture Schedule on the drawing and as manufactured by Bradley, Chicago, Haws, Speakman, Western, Guardian, Acorn Safety, or equivalent.

2.2 FAUCETS

A. Plumbing fixture faucets shall be brass construction and fully chrome plated, unless special finish is specified on the Plumbing Fixture Schedule on the drawings. Faucets shall be furnished complete with all accessories required for the necessary application, including aerators, handles, spouts, and operating cartridges. Contractor shall coordinate exact faucet requirements with required fixture drilling and water and waste rough-in. Faucets for handicapped fixtures shall meet all handicapped and ADA requirements, including a maximum of five (5) pounds of force to activate controls and adjustable metering faucet water flow duration of ten (10) seconds, minimum. Single hole faucets shall have anti-clocking pin to prevent rotation of valve body.

B. Plumbing fixture faucets shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as manufactured by Chicago, Delta, Moen, Speakman, T&S Brass, Zurn, or equivalent, and shall be commercial grade.

2.3 PLUMBING FIXTURE TRIM

A. Plumbing fixture trim including P-traps, supplies, and strainers shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as furnished by Chicago, Brass Craft, McGuire, T&S Brass, EBC, Zurn, or equivalent.

B. Unless otherwise specified, traps shall be copper-alloy adjustable tube-type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal-to-metal or metal-to-plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy, offset style, to match P-trap. Furnish brass or copper wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated.

C. Fixture supplies, strainers, and trim shall be brass construction. Supplies shall be commercial grade, quarter-turn all brass ball valves, plastic stems and handles are not acceptable. Furnish supply with loose key unless otherwise specified. Supply pipe shall be 3/8" O.D., with smooth (non-corrugated) flexible copper riser and wall escutcheon. Supply assembly shall be completely chrome plated for all exposed installations, including installation within cabinets and casework. Strainers and other miscellaneous fixture trim shall be furnished as required for the proper installation and shall be chrome plated to match faucets, unless special finish is required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide all necessary supports and connection materials and trim for plumbing fixtures as required to assure a complete properly installed and operating system. Installation shall be in accordance with manufacturer's recommendations and with International Building Code and Uniform Plumbing Code requirements. The Contractor shall caulk fixtures to the adjacent wall, floor and countertop construction with non-shrink, mildew resistance caulking material.

B. Fixture mounting height shall conform to the ADA Accessibility Requirements and coordinated with the Architectural drawings.

1. ADA required Water Closet shall be mounted with top of seat 17" – 19" above finished floor.
2. ADA required Urinal shall be mounted at a maximum of 17" top of rim to finished floor.
3. ADA required Lavatory to be mounted with the rim or counter surface no higher than 34" above finished floor.
4. ADA required shower controls shall be located from 38" minimum to 48" maximum height above the shower floor.
5. ADA required Bathtub controls shall be located maximum of 48" above bottom of tub surface.
6. ADA required Sinks shall be mounted with counter or rim no higher than 34" above finished floor.
7. ADA required Drinking Fountains or Water Coolers spouts shall be no higher than 36" measured from the floor or ground surface to the spout outlet.

3.2 EQUIPMENT/FIXTURE SUPPORT

A. Furnish and install all "back-up" materials for fixtures and accessories, or as otherwise required by the equipment schedule to properly support and provide a sturdy installation.

3.3 FIXTURE CARRIERS

A. Fixture carriers shall be provided for all wall hung plumbing fixtures, including water closets, urinals, lavatories, sinks, etc., as manufactured by Josam, Jay R. Smith, Watts, Wade, Zurn, MiFab, or equivalent. Carriers shall be bolted to the floor using all of the support bolts recommended by the manufacturer. Where the water closet nipple and studs extend beyond the maximum carrier recommended length, provide additional carrier support as recommended by manufacturer. Water closet carriers shall be horizontal or vertical, single or back-to-back units as required for the fixture installation and piping arrangement, and shall be adjustable.

B. Single water closet carriers shall have factory installed rear hold down lugs and anchor foot to provide cantilever support.

C. Wall hung urinals shall be provided with floor mounted fixture carrier complete with upper and lower fixture support plates as required to match fixture installation requirements.

D. Wall hung lavatories and sinks shall be provided with floor mounted concealed arm type chair carriers, single or double (back-to-back) units as required for the fixture installation and arrangement.

E. Contractor shall be responsible to provide the proper arrangement and selection of fixture carriers required for fully concealed installation in the available plumbing chase and/or wall construction.

3.4 EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall furnish and install complete rough-in and connections, including stop valves on all supply piping for all mechanical services required for equipment furnished and installed under other sections of this specification, and for all owner-furnished equipment.

B. Types of equipment in this category shall include but not be limited to the following: kitchen equipment, shop equipment, hospital and laboratory casework, medical equipment, etc. The Contractor shall provide all pipe fittings, unions, traps, connecting wastes, valves, cocks, regulators, pressure reducing valves, flexible connectors, etc., as required for the services to each piece of equipment.

C. Installation and setting of equipment and fixtures furnished under other Sections of this Specification will not be provided under Division 22 of this Specification, unless otherwise indicated.

3.5 FIELD MEASUREMENTS AND COORDINATION

A. Exact location and rough-in requirements shall be carefully coordinated. Contractor shall refer to drawings and specifications, and shall check manufacturer's data, shop drawings and rough-in drawing submitted under Division 22 and other Divisions of this specification and make all field measurements to the extent necessary to ensure his understanding of the work required to provide for complete rough-in installation.

3.6 CLEANING

A. All fixtures shall be thoroughly cleaned before final acceptance of the work.

END OF SECTION 22 4000

SECTION 23 0500 - COMMON WORK REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this Section and all subsequent sections of this Division and form a part of the contract.

C. See Division 2, Site Work for additional requirements regarding Trenching, Backfilling for buried piping.

D. See Division 25 for Facilities Management System.

1.2 INDEX OF SPEC SECTIONS FOR THIS DIVISION

23 0500 Common Work Requirements for HVAC
23 0503 Trenching and Backfilling
23 0504 Pipe and Pipe Fittings
23 0505 Piping Specialties
23 0523 Valves
23 0548 Mechanical Vibration Control and Isolation
23 0549 HVAC and Electrical Installation Coordination
23 0550 Variable Frequency Drives
23 0593 Testing, Adjusting and Balancing of Mechanical Systems
23 0700 Mechanical Systems Insulation
23 0800 Mechanical Facility Startup-Commissioning
23 2113 Heating Hot Water System and Equipment
23 2114 Chilled Water System and Equipment
23 2123 Pumps
23 2313 Refrigerant Piping System and Equipment
23 3000 Air Tempering System and Equipment
23 3423 HVAC Power Ventilators
23 3713 Diffusers, Registers, and Grilles
23 7313.1 Outdoor Central - Statation Makeup-Up Air- Handling Units
23 8113 Terminal Air-Conditioners
23 8216 Air Coils
23 8413 Self-Contained Steam Humidifier

1.3 DEFINITIONS

A. General: Terms will have meanings as defined in Webster’s Eleventh New Collegiate Dictionary except as noted below.

B. Entities

1. Owner: New Mexico State University (NMSU)
2. Architect: FBT Architects
3. Engineer: Bridgers & Paxton
4. Owner's Representative: The Owner will designate his representative after bid. The abbreviation “OR” may be used throughout these specifications to refer to the Owner’s Representative.
5. Owner's Agents: The Architect, Engineer, and others authorized to act on behalf of the Owner.

C. Actions

1. Supply: Procure and deliver to the site with all features as specified, required per code, and as required for proper installation. Include submittals, O&M manuals, operator instructions, and warranty.
2. Install: Set in place in accordance with manufacturer's instructions, contract documents, and applicable codes and standards. Coordinate the installation with other disciplines, start, and demonstrate proper operation.
3. Furnish: Supply and install.
4. Provide: Supply and install.
5. Accepted: By the Owner’s Representative except as noted.
6. Approved: By the Owner’s Representative except as noted.
7. Review: By the Engineer except as noted.

D. Locations

1. Buried: Surrounded by soil or other material, either beneath the building or exterior to the building.
2. Exterior: Exposed to rain or snow. Examples include rooftop locations, spaces around cooling towers, pipe racks, etc.
3. Interior: Not exterior or buried. Examples include not only spaces within the heated envelope of the building, but also unheated attics, covered loading docks in which spaces are protected from rain and snow, utility tunnels, sheds, etc.
4. Finished Spaces: Interior spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated attics, spaces above ceilings, crawlspaces, and tunnels.
5. Exposed: Exposed to view. Examples include finished spaces mechanical equipment rooms, rooftops, etc.
6. Concealed: Not Exposed.

E. Other Definitions:

1. 24/7: 24 Hr/day, 7 days per week, year-round.
2. AHJ: Authorities having jurisdiction. The authorities having jurisdiction over this project are established by statute, and include governmentally designated building departments, the fire marshal, fire departments, etc. No attempt is made to list all such entities here; a qualified Contractor is expected to know and coordinate with the various authorities having jurisdiction.
3. FMS: Facility Management System

4. Local: Based no further from the job site than the Engineer is. For example, where the specifications call for a local factory authorized service agent, then on a daily basis that agent must be based in an office or warehouse located no further from the project site than the Engineer's office.
5. OAE: Or approved equal.

1.4 CODES AND PERMITS

A. Perform all work in accordance with the 2021 International Building Code, 2018 International Energy Conservation Code, the 2021 Uniform Plumbing Code, and the 2021 Uniform Mechanical Code, as adopted and interpreted by the State of New Mexico and City of Albuquerque, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. Contractor shall hold and save the Owner and his agents free and harmless from liability of any nature or kind arising from the Contractor's failure to comply with codes and ordinances.

A. Secure and pay for all permits necessary for performance of the work, including utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas, unless otherwise specified herein.

B. Comply with the requirements of, and the recommendations of:

1. Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances
2. National Electrical Manufacturer's Association
3. National Electrical Code
4. Underwriters Laboratories
5. American National Standards Institute
6. American Society for Testing Materials
7. Local utility companies
8. National Fire Protection Association
9. ASME Boiler and Pressure Vessel Codes
10. Occupational Safety and Health Administration
11. International Fire Code
12. Midwest Insulation Contractors' Association (MICA)
13. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
14. American Society of Sanitary Engineering
15. American Gas Association

1.5 PRIOR APPROVAL

A. Refer to Division 1 for Prior Approval Requirements.

B. Equipment manufacturers and service providers are listed within the specifications for the work specified in this division. For the items listed below, the specified manufacturers and providers are the only ones presently approved, and may be the only ones allowed:

1. Air Handling Units and Air Conditioning Units
2. Fans
3. Pumps
4. Humidifiers
5. Facility Management System

C. Manufacturers and service providers who are not listed in these specs, and who offer equivalent or superior products or services, are invited to submit for approval prior to bid (prior approval). Submit two copies. Requests for prior approval must:

1. Include the substitution request form at the end of this spec section.
2. Include technical data sufficient for the Engineer to generally assess appropriateness for this project.
3. Be submitted minimum ten days prior to the bid date in effect at the time of submission.
4. Comply with any additional requirements per specification Division 1.

D. Any additional prior approved alternate manufacturers and service providers will be published in an addendum prior to bid. Prior approval indicates that based on the information submitted it appears to the Engineer that the alternate might be capable of meeting the specifications and the design intent, and might be appropriate for the project. But prior approval does not guarantee this. Prior approved products and service providers must still go through the submittal process after award, and must still comply with the design intent and all specification requirements.

1.6 DOCUMENT MANAGEMENT

A. Contractor is encouraged to use a web-based document management system for RFIs and submittals. If used, Contractor shall provide and pay for licenses and training for the engineer's project personnel. The section below describes procedures for handling submittals if a web- based document management system is not used. If a web-based system is used, the procedures below shall be modified as appropriate.

1.7 SUBMITTALS

A. See Division 1 and individual specification sections within this division for additional submittal requirements.

B. Prior to purchasing materials, equipment and services, submit descriptive literature for review.

C. See Division 1 and individual specification sections within this division for additional submission requirements. The following describes general submittal procedures. More specific procedures will be established after award. Whenever electronic files are to be submitted, e- mail them through normal channels. But if files are too large to e-mail, then submit them in quantities as described below.

1. Submittal Schedule: Along with the first item submitted for review, include a schedule listing all items to be submitted and an approximate date for each submittal. Submit this schedule in both hard copy and electronic form (Microsoft Excel). Normal review time will be 10 working days or as indicated in Division 1. Schedule should identify any submittals

for which expedited review is requested. Update this schedule and resubmit it monthly (by e-mail) for information.

2. Include the following information with each submittal:

    a. Cover sheet identifying the project name, contractor, architect, engineer, and items included. Indicate symbol numbers, spec section, etc.
    b. A blank space large enough to accept a review stamp.
    c. Performance under the specified conditions
    d. Cover sheet shall clearly identify and HIGHLIGHT any ways in which the submitted materials, equipment or services deviate from the Specifications.

3. Quantities:

    a. Brochures: Submit no more than seven copies plus a PDF.
    b. Drawings: Submit one reproducible, one print, plus a PDF.

4. Engineer will review one original submittal and one resubmittal for each item. If the Contractor fails to provide the required data or acceptable items with his second submittal, he will be charged for the Engineer's costs for the third and subsequent reviews.
5. Required Information: Submit information to allow the Engineer to easily determine whether the submitted components comply with the general design intent. Include relevant descriptions of materials, features, performance, quality and dimensions. Cross out all features, options and accessories which will not be provided. It is assumed that all specified, indicated and/or required features will be provided unless specifically noted otherwise.
6. Where specifications require a local factory authorized service agent, submit the name, address, and contact information for this agent. Include this information also in the O&M Manual.

D. Review of Submittals: Engineer will review submittals for general conformance with the design intent.

1. Review of a separate item as such will not indicate review of the assembly in which the item functions.
2. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work.
3. Review will not relieve the Contractor of responsibility to comply with the contract requirements, or responsibility to ensure that equipment fits within the allotted space with required clearances for equipment operation, service and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC).
4. For commodity type items (plumbing fixtures, terminal units, registers, diffusers, etc), Engineer will review submittals for type only. Contractor to coordinate sizes and quantities.
5. Actions: Engineer will return submittals with one of the following actions:

NO EXCEPTIONS TAKEN	Contractor may proceed with the work as submitted

EXCEPTIONS AS NOTED	Contractor may proceed with the work and Without resubmittal provided he complies with all exceptions noted in the submittal, and so states in a letter
REVISE AND RESUBMIT	Resubmit in accordance with the indicated comments
REJECTED	Resubmit in accordance with the contract documents
RETURNED WITHOUT ACTION	This submittal has not been reviewed, and Therefore the Engineer is returning it with no direction to the Contractor

E. Substitutions:

1. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or if any work is installed in a manner which is not in conformance with the requirements of this specification and for which the Contractor has not received written authorization, remove such unauthorized work and install work in accordance with the contract documents at no change in contract amount.
2. Authorized Substitutions: Provide all accessories and features as required and coordinate substitutions with other disciplines. Bear any extra expenses resulting from the use of substitutions which affect adjoining or related work required in this division or other divisions of the work.
3. If the Contractor substitute's equipment for that indicated on the drawings, he shall prepare a 1/4 inch = 1foot installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will properly fit within the space with adequate clearance for maintenance and replacement. Submit this drawing for review.

F. Schedule: Submit all submittals in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time. Be aware that there is risk in ordering components, fabricating work, and/or installing work prior to review. If the Contractor proceeds prior to review, and then the review comments required modifications to work which has begun or has been completed, then Contractor must comply with the review comments at no change in contract amount or schedule.

G. Shop Drawings

1. Submit shop drawings for

   a. Mechanical equipment rooms and other spaces housing air handling equipment, heat transfer equipment, fluid handling equipment, machinery, etc.
   b. Complete supply, return, and exhaust ductwork systems, both exposed and concealed.
   c. Piping for HVAC, plumbing, and fire protection systems, both exposed and concealed.

2. Show the location and elevation of all equipment, ductwork and piping, as well as openings through slabs and walls. Include plans, elevations and sections as appropriate. Clearly show the manner in which the systems fit into the available space and relate to each other and to the building elements. Indicate required sleeves and openings in general construction

elements. Indicate required clearances for operation, maintenance and replacement of operating devices and equipment. Drawings shall be of appropriate scale to facilitate coordination and understanding, but not smaller than 1/4 inch scale for floor plans and 1/4 inch scale for equipment rooms and chases.

3. Conflicts: The engineer has endeavored to work out conflicts in areas where the design is congested, but has not tried to show all required offsets to coordinate with the building construction and building systems, particularly in less congested areas. The intent is that the Contractor coordinate the design of the piping and ductwork distribution systems with the building construction and the various building systems, particularly in less congested areas. Provide experienced designers to perform such services and prepare shop drawings. Exercise good design practice in working out conflicts without compromising system operation or maintenance. Provide fittings, offsets, etc., as required. Contractor shall include this design effort and include the labor and materials for such fittings and offsets in his base bid. Except in extremely unusual circumstances, no additional costs will be allowed related to working out conflicts. Coordinate with other disciplines as required. Identify on the shop drawings those areas where redesign was necessary to resolve design conflicts.

    a. In the event that the Contractor desires direction in resolving a design conflict or desires prior approval of a recommended approach to resolving a conflict, submit an RFI which identifies the conflict and suggests a recommended solution.
    b. In resolving conflicts, gravity lines and larger distribution mains will generally have priority over pressurized lines and smaller lines as follows:

        Plumbing waste and vent lines
        Roof drains
        Steam and condensate piping
        Supply, return and exhaust ductwork
        Fire sprinkler mains
        Heating hot water and chilled water piping
        Domestic hot and cold water
        Fire sprinkler branch piping and sprinkler runouts
        Pneumatic control piping
        Miscellaneous special piping systems

4. Use of Engineer's CADD Database or BIM Model: The Engineer will provide the Contractor electronic files of the Engineer's CADD Database or BIM Model of the design documents if the Contractor completes and submits the License Agreement form included at the end of this spec section. These files show the general design intent and may be used as a starting point for the Contractor to begin his shop drawings and coordination effort, but the Contractor should not use them as a basis for ordering or fabrication. The normal submittal process still applies, regardless whether the Contractor elects to use the Engineer's CADD Database or BIM Model.

H. Submittals Required under this Specification Section:

1. Electrical Components: Motors, Motor Controllers, and Variable Speed Drives
2. Identification: Products used to identify equipment, ductwork, valves, piping, and control devices.
3. General Construction Components: Roof Curbs & Access doors.

1.8 DOCUMENTED COORDINATION EFFORT

A. Refer to Division 1 for coordination drawings requirement.

B. After shop drawings are reviewed, incorporate any review comments and then participate in a formal and documented coordination effort with the contractors and subcontractors for other divisions of the work. Show all piping systems and equipment on the ductwork drawings, and send electronic CADD files to the General Contractor and the subcontractors for plumbing, fire protection, electrical, and other disciplines. The other subcontractors will then add their work to the CADD files.

C. Make full-size plots of the drawings. Participate in meetings with the GC and other subcontractors to review each area, identify conflicts, and resolve conflicts. Submit the resolutions to the Engineer for review. Maintain adequate space for operation, maintenance, and code-required clearances. Ensure that all subcontractors initial each plan to indicate that they have participated in the coordination effort.

1.9 MISCELLANEOUS PROVISIONS

A. Qualifications

1. All mechanics shall be skilled in their respective trade.
2. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

B. Regulated Materials: Comply with all state, local and federal regulations regarding the storage, handling or disposal of oils, lubricants, cleaning agents, refrigerants, other liquids and gases, and hazardous materials.

C. Factory Identification: Provide all materials and equipment with labels sufficient to show compliance with these specifications and the performance requirements indicated on the drawings. All equipment shall carry a permanent label installed by the manufacturer stating that the equipment complies with ASHRAE/IESNA Std. 90.1.

D. Hazardous Conditions: Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

E. Hazard Signs

1. Provide a sign reading, "Hazardous Area - Authorized Personnel Only" on the doors to all equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments.
2. Provide a sign reading, "Confined Space - Entry by authorized personnel only by permit" for all confined spaces. Confined spaces shall be as designated by OSHA Standard 1910.146. This generally means a space that:

    a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and

b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
c. Is not designed for continuous employee occupancy.

F. Survey the final premises to determine where any potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.10 GUARANTEE-WARRANTY

A. See Division 1 for additional information on warranties. Warranties shall run for one year from substantial completion unless indicated otherwise.

B. The following warranty shall be binding:
"The Contractor warrants that this installation is free from mechanical defects. Contractor agrees to replace or repair any part of the installation which may fail within a period of one year after the date established below, provided that such failure is due to defects in materials or workmanship, or to failure to follow the specifications and drawings. This warranty shall begin on the date set forth in the Certificate of Substantial Completion, AIA Form G704, or other such date as documented in writing by the Owner's Representative."

C. The extent of guarantees or warranties by equipment and/or materials manufacturers will not diminish the requirements of the Contractor's warranty to the Owner.

PART 2 - PRODUCTS

2.1 PRODUCT GENERAL REQUIREMENTS

A. General: Products supplied under Division 23 shall comply with the following except as noted elsewhere.

B. Products shall be new; shall be the product of manufacturers regularly engaged in the production of plumbing, heating, ventilating, air conditioning, and control system equipment; and shall be the manufacturer's latest design. Specs and equipment schedules establish expectations regarding standard of quality and operating intent.

C. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

D. Products shall be suitable for the conditions under which they are installed and operated. Prior to or during the submittal phase advise the Owner’s representative and the Engineer in writing regarding any concerns about the suitability of the specified products for the intended application or service. Request clarification if any question exists regarding the design intent.

E. Performance Ratings: Unless otherwise noted, all scheduled equipment performance is based on an elevation of 4500 feet above sea level. Adjust manufacturer's ratings accordingly.

F. Structural Soundness: Products shall have structural integrity appropriate to the component and its application. Bases shall be rigid and shall keep all components in proper alignment. Structural integrity shall be adequate for both rigging and final installation. Components shall not be loose, rattle, or vibrate unnecessarily in their final installed condition.

G. Corrosion Resistance: Equipment shall be of materials inherently corrosion resistant, or shall be finished with a corrosion-resistant finish suitable for the location in which the equipment is installed.

H. Touch-up: If the factory finish of any component is damaged prior to substantial completion, touch up to original condition per manufacturer's recommendations.

I. Equipment Access Doors or Panels: Provide access doors and panels within equipment to ensure good access to all components requiring inspection, service or maintenance. Provide appropriate hardware. Equipment installed outdoors shall be weather-tight.

J. Fans: Statically and dynamically balanced, shaft first critical speed shall be above operating speed at design conditions.

K. Bearings: Grease lubricated or permanently lubricated.

L. V-Belt Drives: All components sized for 150% of motor HP, multiple belts shall be matched, fixed sheaves for motors 20 Hp and larger, adjustable sheaves for lower HP motors, all safety components for OSHA compliance (e.g., belt guard or other safety provisions) motor mounted on adjustable base. Provide a replacement sheave for each fixed sheave after T&B is complete. Include belt data in O&M manual. Gates Rubber Co, OAE.

M. Belt Guards: Rigidly constructed and attached, removable, galvanized steel, expanded mesh. Design to provide ready access to bearings.

N. Couplings: Provide coupling guard.

O. Motors and VFDs: See requirements described elsewhere in this spec section.

P. Drive Lines (starter or VFD, motor, coupling and shaft or v-belt drive and pulleys, and driven equipment): Coordinate with all suppliers and ensure all components are compatible to work as a system.

Q. Coils: ARI rated, copper tubes mechanically expanded into aluminum fins, galvanized steel casing, drainable, pressure tested to 150% of working pressure but not less than 300 psi.

R. Cooling Coil Drain Pans: Provide for all cooling coils, galvanized or stainless steel, double itched with piped outlet. For units with more than one coil stacked, provide intermediate drain pans piped to the main drain pan.

S. Gas Burners: Natural gas fired, performance based on gas at 1000 Btu/SCF HHV but suitable for use with gas at 900 – 1050 Btu/SCF and 7 – 11 inches water column, factory installed and pressure tested gas train, all necessary safety and operating controls.

T. Filter Frames: Galvanized steel, provide wherever filters are specified.

U. Roof Curbs and Support Rails for Roof-Mounted Equipment: Roof curbs should generally be supplied with the equipment which the curb supports, and shall comply with the requirements of the National Roofing Contractors' Association. Match curb to the requirements of the supported equipment. The roof pitch is indicated on the architectural drawings. If roof pitch exceeds the recommendations of the equipment manufacturer, provide a curb that will level the equipment. Factory fabricated, minimum 16-inch, structurally adequate for the load supported, not less than welded 18-gauge (16-gauge or heavier for sizes more than 50-inches) galvanized steel with minimum 1-inch fiberglass insulation, 2 x 2 wood nailer, and with cant and step if required to match specified roof. Provide damper tray for un-ducted fan applications. Ship small curbs fully assembled; large curbs may be knocked down for shipment.

V. Electrical & Controls: Except where specifically noted, electric service to each component listed on the equipment schedules will be through a single electrical feed at the voltage indicated on the equipment schedules. Include all components, cabling and conduits to distribute power to all components which are factory supplied and mounted. Provide transformer(s) if required to serve unit-mounted components requiring electric service at voltages different from the main electric service, including controls components. Provide secondary overcurrent protection. Provide terminal strips for field-installed control wiring. Provide unit-mounted, unit-specific wiring diagrams on durable paper, attached to inside of control panel door or otherwise affixed to the unit. All electrical components shall be UL Listed or Recognized. All factory-installed electrical work shall comply with the NEC unless the overall unit is listed by an organization acceptable to the AHJ, and listed to a standard acceptable to the AHJ.

1. Where equipment includes an LCD or other, similar display for operator interface, display all information in English. Displays should be readily understandable and should not require the user to look up display codes in a reference manual.
2. Provide battery backup to retain all memory and programming, and to keep all clock-related functions powered through a 1-week power outage.
3. Controls interface with the FMS:

    a. Digital Inputs to FMS: 24V DC sourced from equipment.
    b. Digital Outputs from FMS: Equipment to have form C relays, max 250V DC, 2 A.
    c. Analog Inputs to FMS: 4-20 mA, 0-5V DC, or 0-10V DC sourced from equipment.
    d. Analog Outputs from FMS: 4-20 mA sourced from FMS.

2.2 ELECTRICAL COMPONENTS

A. General: Except as noted, all electrical products and equipment shall comply with the requirements of this section, whether field installed or factory installed. See "Product General Requirements" and "Installation General Requirements" in Parts 2 & 3 of this spec section for additional requirements.

B. Motors

1. General: Except as noted motors shall be horizontal, open drip-proof, 4-pole, 1750 RPM, rated per NEMA MG-1, with fabricated steel or cast iron casing, motor terminal box adequately sized for conductors one-size larger than specified, SS nameplate per NEMA MG-1-20.60, connection diagram attached to motor, compression lugs for power feeds and ground conductor, grease lubricated sealed ball bearings or roller bearings with standard

grease fitting zerk and relief tapping, factory lubricated, dynamically balanced to no more than 50% of the NEMA allowable vibration limits. For motors powering V-belt drives, provide a cast iron or steel base with slide rail and adjustable belt tension device. Install motors and equipment on foundations and align as required. 40 deg C rise and total temperature rise of 65 deg C ambient.

a. 3/4 hp and smaller: 115V, single phase, 60 Hz, split phase or permanent split capacitor (PSC), NEMA Type N or O, with built-in thermal overload protection.

1) Multi-speed motors.

b. 1 hp and greater: 460 V, 3 phase, 60 Hz, squirrel cage induction type, NEMA design B, T-frame, with Class B or F insulation, lifting lugs, 150,000 hr L-10 bearings for direct-coupled applications, 50,000 hr L-10 bearings for belt-driven application with radial loads and pulley sizes per NEMA MG1-14.43. Service Factor: ODP motors shall be rated for 1.15 SF at 40oC or 1.0 SF at 65oC; TEFC motors shall be 1.0 SF.

1) Two speed motors: Provide with two separate windings.
2) Variable speed motors: Drive compatible per NEMA MG1-31, premium efficiency as specified below regardless of Hp, Class F insulation, minimum 5-year warranty.

2. Efficiency: Except as noted, motors shall be premium efficiency type, with nominal efficiencies not less than the following as per the Consortium on Energy Efficiency (CEE), and minimum power factor of 0.85:

	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
HP	1200 RPM	1800 RPM	3600 RPM	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7
20	92.4	93.0	92.4	92.4	93.0	92.4
25	93.0	93.6	93.0	93.0	93.6	93.0
30	93.6	94.1	93.0	93.6	93.6	93.0
40	94.1	94.1	93.6	94.1	94.1	93.6
50	94.1	94.5	93.6	94.1	94.5	94.1
60	95.0	95.0	94.1	94.5	95.0	94.1
75	95.0	95.0	94.5	95.0	95.4	94.5
100	95.0	95.4	94.5	95.4	95.4	95.0
125	95.4	95.4	95.0	95.4	95.4	95.4
150	95.8	95.8	95.4	95.8	95.8	95.4
200	95.4	95.8	95.4	95.8	96.2	95.8

3. Approved Manufacturers: General Electric Energy Saver, Baldor Super-E, Marathon Series E, Reliance Electric XE, Westinghouse TEE II, Eaton/Cutler Hammer, Toshiba, Louis Allis, or approved equal.

4. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with all other parties (e.g. electrical contractor) and pay any costs associated with the change.

C. Motor Controllers

1. Single Phase Manual Starters to 1 Hp and 120-277 V: Cutler Hammer MS with indicating light.
2. 3-Phase: Full voltage, non-reversing, electro-mechanical, combination circuit breaker and motor controller, UL Listed, NEMA rated, 460V, 65,000 AIC, minimum 50 VA 24V controls transformer with secondary overcurrent protection, suitable for operation at -4oF to +149oF and specified voltage -15% to + 10%, adjustable solid state overloads initially set at Class 10, HOA switch, run indicator, two auxiliary contacts for remote monitoring of status, and enclosure for surface mounting. Cutler Hammer OAE.

a. Provide enclosure appropriate to the location:

1) NEMA-1 for indoor dry locations.
2) NEMA-3R for outdoors.
3) NEMA-4 for wet applications.
4) NEMA-12 for dusty locations.
5) Explosion-proof – where required.

b. Motor controllers factory mounted and wired on AC units, boilers, etc, may be definite purpose, and need not have all the features specified here.

3. All ECM motors shall include a factory motor controller which provides “Hand-Off-Auto” capability, isolation damper control, and fan status contacts. Controller voltage and damper actuator voltage requirements shall match the motor voltage requirements.

2.3 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. Provide wiring and conduit as scheduled in Section 23 0549.

B. Coordinate with all disciplines to ensure that all necessary components of control work are included and fully understood.

C. All wire pulled for mechanical equipment communications to FMS (BMS) shall be run in a separate dedicated conduit to minimize potential noise being generated on the communications line.

2.4 IDENTIFICATION

A. Scope: Identify all equipment, ductwork, valves, piping, and control devices shown on the Drawings, identified in the equipment schedules, and indicated in these Specifications. Provide submittals for products and procedures used for identification.

B. Equipment: For all mechanical equipment supplied or installed under Division 23, provide an equipment identification tag or stencil unit number onto the equipment. Stencils shall be minimum 3-inch height, dark contrasting color, of a material suitable for the application.

1. For rooftop HVAC equipment, provide a permanently affixed, weather-resistant label to identify the areas served.

C. Valves: Provide each valve with a stamped metal tag secured to the valve. Tag shall indicate the valve number, service and function. Provide two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Drawings shall be neat and easily readable. Provide a typed valve chart, listing the valve number, size, location, function, normal operating position, for each valve. List valves by system, i.e., domestic cold water, hot water, chilled water, etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

D. Ductwork: Identify ductwork at or near the fan with stenciled signs on insulated ductwork or engraved laminated plastic signs secured by rustproof screws on un-insulated ductwork. Sign shall identify air conditioning system or fan unit and area served.

E. Piping

1. Provide color-coded pipe labels indicating the service of the pipe and the direction of flow. Piping labels shall comply with ANSI Standard A13.1 regarding color coding and size of lettering. The following standardized color code scheme shall be used:

    a. Yellow - Hazardous Materials.
    b. Green - Liquid Materials of Inherently Low Hazard.
    c. Blue - Gaseous Materials of Inherently Low Hazard.
    d. Red - Fire Protection Materials.

2. Labels shall be semi-rigid plastic identification markers. Labels shall "span-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4 inch through 5 inches. Labels for piping 6 inches and larger shall be furnished with spring attachment at each end of label. "SETMARK" Type SNA, 3/4 inch through 5 inch size and Type STR, 6 inches and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.
3. Labels shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.
4. For retrofit projects the system names shall match existing.
5. Attach pipe markers to lower quarter of the pipe on overhead horizontal runs and on the centerline of vertical piping where view is not obstructed.
6. Provide the following labels, with ANSI/OSHA color and banding for all piping systems as shown on the Drawings and as listed below:

Service/Legend	Letter Color	Background Color	Tape Banding Color
Domestic Cold Water	White	Green	2" Green
Domestic Hot Water	Black	Yellow	2" Yellow
Domestic Hot Water Return	Black	Yellow	2" Yellow
Soft Cold Water	White	Green	2" Green
Soft Hot Water	Black	Yellow	2" Yellow
Industrial Cold Water	White	Green	2" Green
Fire Protection Water	White	Red	2" Red
Fire Auto Sprinkler	White	Red	2" Red
Fire Dry Standpipe	White	Red	2" Red
Fire Wet Standpipe	White	Red	2" Red
Fire Comb. Standpipe	White	Red	2" Red
Compressed Air	White	Blue	2" Blue
Roof Drain	White	Green	2" Green
Sanitary Sewer	White	Green	2" Green
Storm Sewer	White	Green	2" Green
Natural Gas	Black	Yellow	2" Black
Steam, PSIG	Black	Yellow	2" Black
Condensate Return, Gravity	Black	Yellow	2" Black
Condensate Return, Pumped	Black	Yellow	2" Black
Boiler Feed Water	Black	Yellow	2" Black
Chilled Water Supply	White	Green	2" Green
Chilled Water Return	White	Green	2" Green

Service/Legend	Letter Color	Background Color	Tape Banding Color
Heating Water Return	Black	Yellow	2" Yellow
Condensing Water Supply	White	Green	2" Green
Condensing Water Return	White	White	2" Green

7. Locations: Label pipes at the following points on each piping system:

   a. Adjacent to each valve in piping system.
   b. At every point of entry and exit where piping passes through a wall.
   c. On each pipe riser and junction.
   d. At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
   e. Adjacent to all special fittings (regulating valves, etc.) in piping systems.
   f. At every access door.

F. Underground Piping: Provide a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6 inches to 8 inches below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type.

G. Control System Devices: All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the Contract Drawings.

2.5 GENERAL CONSTRUCTION COMPONENTS

A. Roof Curbs and Equipment Support Rails

1. General: Factory fabricated, minimum 16-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction. Actual curb heights to be coordinated by contractor with roofing insulation height to maintain code-required height above final roofing elevation.
2. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, RPS, OAE.
3. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck, RPS, OAE.

B. Access Doors (ADs)

1. Steel frame and door, surface mounted, factory primed, 150o opening, flush, screw-driver operated cam lock, minimum 24” x 24” except as approved, but larger where required for proper access. Where ADs are installed in general construction with a pattern, match AD dimensions to this pattern. Milcor, Krueger, OAE.

    a. Sheet Rock Wall or Ceiling: With drywall bead on frame, Milcor Style DW.
    b. Plaster Wall or Ceiling: Milcor Style K.
    c. Masonry Walls: Milcor Style M.
    d. 1-hr and 2-hr rated walls: UL Listed for 1.5-hr Class B Fire Rating, self-closing and self-latching. Milcor Style UFR.
    e. Suspended Ceilings: Milcor Style AT.
    f. Fire Rated Suspended Ceilings: Milcor Style ATR.

C. Painting: Finish painting of mechanical systems and equipment will be under Spec Section 09 9100, “Painting," unless equipment is specified to be provided with factory-applied finish coats.

2.6 MISCELLANEOUS PROVISIONS

A. Flow Diagrams: Provide half-size prints of each system flow diagram, including air handling, steam, chilled water, heating water, domestic water, domestic HW, etc. Mount framed under plexiglass, and locate either on the associated AHU or on a nearby wall. Incorporate any as- built revisions.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL REQUIRMENTS

A. Cooperation with Other Trades: Refer to other parts of these Specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. Be responsible for the size and location of all openings, foundations, etc.

B. Trenching and Backfilling: Provide all excavation, trenching and backfilling required for the installation of the work of this division.

C. Manufacturer's Instructions: Install all products in accordance with manufacturers' recommendations and the requirements of any applicable listings. If manufacturers' recommendations and/or requirements of applicable listings conflict with plans and specifications, report such conflicts to the Owner's Representative.

D. Field Measurements: Verify all dimensions and conditions governing the work. Examine adjoining work on which the work of this Division is dependent, and report any deficiencies.

E. Do not compromise the building structural, fire resistant construction or vapor barrier system.

F. Supports for Equipment and Systems: Foundations and structural supports for equipment will generally be provided by others. The contractor for this division shall provide supplementary supports as required to support equipment, distribution systems, and other components installed under this division. Prior to installing mechanical work, examine foundations and supports to ensure they are adequate to properly support the equipment. Provide all necessary foundations, structures, supports, inserts, sleeves, etc, for installation of mechanical and plumbing equipment, ductwork and piping, etc. Coordinate installation of such devices with all disciplines. Verify that the devices and supports are adequate as intended and do not overload the building structure.

G. Concealed or Buried Work: For work which is underground or which will be concealed by building construction, provide digital photographs to document the installation throughout the construction project, but not less than weekly. Include plans indicating where the photographs were taken. Notify the OR of when the work will be complete and provide OR a minimum five-day period to inspect the work after completion but prior to when it is backfilled or concealed by building construction.

H. Access Doors: Provide as required for access to valves, dampers, controls, or other items for which access is required for either operation or servicing. The type of access door shall be as required by the room finish schedule.

I. Alignment of Flexible Couplings: Flexible couplings between motors and driven equipment shall be aligned by a qualified service technician after the equipment is installed and ready for operation. Align equipment per manufacturer's recommendations under operating conditions and temperature. Provide written certification that each device has been so aligned.

J. Lubrication: Provide all oil for the operation of all equipment until acceptance. Be responsible for all damage to bearings while the equipment is being operated by Contractor up to the date of acceptance of the equipment. Protect all bearings and shafts during installation and thoroughly

grease shafts to prevent corrosion. Bearings for items of mechanical equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

K. Tests: All tests shall be conducted in the presence of the designated and authorized Owner's Representative. Notify the Owner's one week in advance of all tests. Requirements for testing are specified under the sections covering the various systems. Provide all necessary equipment, materials, and labor to perform the required tests.

L. Protection of Material and Equipment:

M. Protect all work, materials and equipment furnished and installed under Division 23, whether incorporated in the building or not.

N. All items of mechanical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner as approved.

O. Protect all work and be responsible for all damage done to property, equipment and materials. Coordinate material storage with the Owner's Representative.

P. Pipe and duct openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. Plumbing fixtures shall not be used by the construction forces. At the completion of the work clean and polish fixtures, equipment and materials prior to turning them over to the Owner.

Q. Systems Commissioning: A commissioning Agent will participate in the construction phase of the project.

3.2 DRAWINGS

A. The drawings show the general arrangement of the piping, ductwork, equipment, etc. Follow them as closely as actual building construction and work of other trades will permit. Where discrepancies occur between Plans and Specifications, the more stringent shall govern. All

B. Contract Documents shall be considered as part of the work. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories, which may be required, and no attempt has been made to do so. Rather, the drawings convey the general design intent. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing fittings, valves, and accessories as required to meet such conditions. Show any such changes on the Record Drawings.

C. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, submit an RFI.

D. Install equipment, piping, ductwork, and electrical systems with proper clearance for operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions, etc. Include proper clearance in front of and above electrical equipment as defined by the National Electric Code (NEC). Piping and ductwork systems shall not be routed through or above electrical equipment rooms, telecommunications

rooms, elevator machine rooms, or electrical equipment spaces within mechanical equipment rooms.

E. The unique design features of this project will necessitate that the contractor for this division provide greater than normal levels of coordination and cooperation with other disciplines.

F. Arrange all concealed mechanical systems carefully to fit within the available space without interference with adjacent structural and electrical systems. Make all necessary provisions for penetrations of piping and ductwork, including sleeves and blockouts in structural systems. The exact location of all exposed mechanical systems, including grilles, registers, and diffusers; access doors; sprinkler heads; piping and ductwork exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it relates to the aesthetic design for the facility.

3.3 EQUIPMENT SUPPLIED BY OTHERS

A. Certain items of mechanical equipment as listed on the Drawings and/or Specifications will be furnished under other sections of this Specification for mechanical rough-in and connection under Division 23, including plumbing, domestic water and waste, process cooling water, compressed air, exhaust, etc.. All required mechanical services, including connection of such services to equipment shall be provided under Division 23.

3.4 INTERRUPTING SERVICES

A. Coordinate the installation of all work within the building in order to minimize interference with the operation of existing building mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

3.5 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of mechanical equipment unless specifically deleted by the Specifications or Drawings.

B. Be responsible for the accurate dimensions of all pads and bases and furnish and install all vibration isolators, anchor bolts, etc.

C. Provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the Drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these Specifications. Pad foundations shall be 4 inches high minimum, unless otherwise indicated on the Drawings. Chamfer edges shall be 1 inch. Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1 inch larger than bolt diameter. Anchor bolts shall be high strength steel J-shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, and then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.6 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

3.7 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the installation for the equipment listed below. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

1. Pumps
2. Water Softener
3. Domestic Hot Water Heaters
4. Steam Pressure Reducing Stations
5. Air Handling Units
6. Fans
7. Humidifiers
8. Facility Management System (See Division 25)

3.8 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems for the benefit of the Owner prior to substantial completion will be allowed provided that a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems for the benefit of the Contractor, except for the purposes of testing and balancing, will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.9 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. At completion of the project provide two complete bound sets of the following documents, along with two CDs containing searchable PDFs of these documents. Organize bound information in a logical fashion with a table of contents and tabs for the different sections. Organize PDFs in a logical fashion with bookmarks to assist the operating personnel in retrieving desired data. Provide minimum two 1-hour sessions to instruct Owner's facility personnel in how to find information in the bound O&Ms and the PDFs. Take attendance and submit the attendance list to the Owner's Representative. Include the following:

1. Approved Submittals.
2. Test reports.
3. O&M manuals and instructions covering all equipment supplied under this Division, with all non-applicable information crossed out. Clearly identify all required routine maintenance. Include parts lists.
4. A master Lubrication Chart listing each piece of equipment, the recommended oil or grease, and the recommended frequency of lubrication.
5. The names and addresses of at least one service agency capable of providing required maintenance for each item of equipment supplied.
6. Complete temperature control diagrams including control descriptions, system sequence of operation, operating instructions, control system maintenance and calibration information, wiring diagrams, and all control setpoints. See Section 23 0900 for additional requirements.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Submit O&M manuals for review and distribution to the Owner not less than two weeks prior to the date scheduled for O&M instructions as specified.

D. Demonstrate proper system operation to the owner's operating staff. Provide the services of the contractor and subcontractors (e.g., mechanical, T&B, temperature control, etc), as required to properly demonstrate system operation.

E. Provide the necessary skilled labor and helpers to operate the mechanical systems and equipment for a period of 5 days of eight hours each. During this period, instruct the owner’s facility staff fully in the operations, adjustment and maintenance of all equipment provided. Provide at least two weeks advanced notice, with a written schedule of each training session, the subject of the session, the Contractors' Representatives who plan to attend the session, and the time for each session. Take attendance and submit attendance sheets to the Owner's Representative.

F. Film the instruction and training sessions submit two copies of the DVD.

3.10 RECORD DRAWINGS

A. See Division 1, for additional requirements associated with Project Record Drawings.

B. Maintain a full-size set of marked-up prints showing the installed location and arrangement of all work under this division, and in particular where changes were made during construction. Keep record drawings accurate and up-to-date throughout the construction period. Owner's Agents may request to review record drawings during construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFIs, bulletins, and change orders neatly taped or attached to record drawing set. At the completion of the project send the Engineer full-size plans clearly showing all changes from the original design marked up in red so as to facilitate the Engineer incorporating these changes into the Engineer's CADD files. Forward record drawings to the Owner's Representative prior to submitting a request for substantial completion.

3.11 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Engineer may make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the work so as to determine if such work is proceeding in general accordance with the Contract Documents. This observation will not release the Contractor from his responsibility to supervise, direct, and control all construction work and activities. The Engineer has no authority over, or responsibility for means, methods, techniques, sequences, or procedures of construction or for safety precautions and programs, or for failure of the Contractor to comply with applicable laws, regulations, or codes.

B. Prior to substantial completion, request that the Engineer provide a final observation visit. Complete the attached "Final Observation Checklist," and include it with this request. For any items that are not applicable, mark them "N/A.

3.12 PROJECT CLOSEOUT

A. Submit written certification that all work complies with the specifications and applicable codes. Submit certifications and acceptance certificates including proof of delivery of record drawings, O&M manuals, spare parts required, and equipment warranties.

END OF SECTION 23 0500

Project:_____ Date Submitted:_____

General Contractor:_____ Date of Final Mechanical System:_____

Mechanical Contractor:_____ Observation Requested:_____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

PLUMBING/PIPING

_____1. All plumbing fixtures are set, sealed and cleaned.

_____2. All domestic and HVAC pipe systems are insulated.

_____3. All pipe systems are identified with specified labels and directional arrows.

_____4. Floor sinks and drain grates are cleaned and debris removed.

_____5. Valve tags are installed.

_____6. Special equipment (water softeners, water heaters, piping systems, etc.,) have been checked and put into service.

_____7. Medical gas systems have been checked and certified.

_____8. Special piping systems have been cleaned and pressure tested.

_____Fuel Handling	_____Process Piping
_____Compressed Air	_____Nitrogen
_____Natural Gas	_____Vacuum
_____Other	_____Argon
_____Medical Gas	_____Other

_____9. Limestone chips have been installed in acid dilution sumps.

_____10. Plumbing/piping connections have been completed to Owner-furnished equipment and equipment furnished by other Contractors/Subcontractors.

_____11. Exterior wall hydrants have been cleaned.

_____12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.

_____13. Drains and relief lines from plumbing and HVAC equipment have been installed and secured in a proper manner.

_____14. All plumbing equipment and areas of equipment have been cleaned and debris removed.

_____15. All plumbing equipment required by the Specifications has been identified and/or numbered.

_____16. Domestic water systems sterilization has been completed.

_____17. Refrigerant piping/system has been charged and tested.

_____18. Strainers/suction diffusers have been cleaned.

_____19. Backflow preventers have been tested.

_____20. Air has been vented from all coils and systems.

_____21. Water treatment systems have been charged and tested.

_____Chilled Water
_____Hot Water
_____Condenser Water
_____Steam/Condensate

_____22. Ethylene glycol system has been charged with correct mixture and tested.

_____23. Water systems have been cleaned (X) and pressure tested (P)

_____Chilled Water
_____Hot Water
_____Steam
_____Condensate
_____Fire Protection
_____Sanitary Sewer and Vent
_____Roof and Overflow Drains
_____Condenser Water
_____Non-potable Water
_____Domestic Hot Water
_____Domestic Cold Water
_____Acid Waste and Vent
_____Heat Recovery Piping
_____Other (list)

_____24. PRVs have been adjusted

(water, steam, gases). FIRE PROTECTION

_____1. Fire protection piping is completed.

_____2. Fire protection system has been certified by the Fire Marshal's office.

_____3. All electrical interlocks between the fire sprinkler components and the fire panel have been checked for operation.

_____4. Spare sprinkler head, wrench and

cabinet are installed. HVAC - EQUIPMENT AND

DUCTWORK

_____1. All ductwork has been sealed and insulated.

_____2. Return air paths and transfer openings have been verified

_____3. Air handlers have been cleaned inside and out and construction filters removed and replaced with final filters.

_____4. All air handling equipment has been started and operated for the specified time.

_____5. All equipment isolators have been adjusted for specified deflection.

_____6. All VAV boxes, fan coils, or fan powered boxes are completed and operational.

_____7. All pump shafts and couplings have been aligned.

_____8. Ductwork, coils, housing, diffusers, registers and grilles have been cleaned.

_____9. Boilers have been fired and certified by the supplier.

_____10. Cooling towers have been started and inspected by the supplier.

_____11. Chillers have been charged, started and certified for operation by the supplier.

_____12. Fire dampers are accessible and fully operational.

_____13. All HVAC equipment has been lubricated.

_____14. HVAC equipment has been labeled in accordance with the Specifications.

_____15. Duct pressure testing is complete and accepted.

_____16. "HAZARDOUS AREA" signs installed where applicable.

_____17. Belt guards installed where applicable.

_____18. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

_____19. Testing and balancing has been completed, and deficiencies noted have been corrected.

_____20. Special systems have been started and tested, such as: Humidification, laboratory hoods, kitchen hoods, and Owner-furnished items.

TEMPERATURE CONTROLS

_____1. Temperature control panels and devices have been labeled in accordance with the Specifications.

_____2. All control dampers close completely and edge and blade seals form tight seal.

_____3. All control valves have been piped as required by the Drawings.

_____4. Controls systems are completed and all control points are operating and recording properly.

_____5. All temperature control tubing and wiring is installed and secured in accordance with the Specifications and the electrical code.

_____6. Smoke removal fans and/or smoke detectors have been tested for operation and shutdown.

_____7. Freezestats have been tested ensuring fan shutdown and full damper closure.

_____8. Operator training for temperature controls has taken place.

_____9. Refrigerant sensors and equipment room shutdown

have been tested. GENERAL ITEMS

The following specified items have been submitted:

_____1. Record Drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 23 0500).

_____4. Testing and balancing reports.

_____5. Test kits furnished to Owner.

_____Flow Measuring Devices
_____Flow Balance Valves
_____Flow Control Devices

_____6. Temperature control schematics and sequence of operation.

_____7. Wall-mounted lubrication, valve, and temperature control charts have been installed.

DIVISION 23 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS

PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section _____ Page _____ Paragraph/Line _____ Specified Item _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐

If YES, explain

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

_____

_____

4. Does the substitution affect drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades?
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐

If YES, explain:

7. Will substitution affect progress schedule? YES ☐ NO ☐

If YES, explain:

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐

If YES, explain

9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: Date:

Address:

Signature: Telephone:

For Engineer's Use Only

Accepted_____ Not Accepted _____Received Too Late _____
By: _____Date:_____
Remarks:_____

LICENSE, INDEMNITY AND WARRANTY AGREEMENT

BETWEEN	Bridgers & Paxton Consulting Engineers 4600-C Montgomery Blvd NE Albuquerque, NM 87109
And the Contractor	**[NAME]**
	[Address]
	[Address]

For use of BIM – Building Information Modeling produced by Bridgers & Paxton Consulting Engineers, Inc. (B&P) in conjunction with the referenced project:

PROJECT: [Project Name and B&P Job #]

THE CONTRACTOR ACKNOWLEDGES THE FOLLOWING:

1. The model remains the property and control of B&P unless otherwise stipulated in separate contractual agreements with the Architect and/or Owner. Providing access to the model does not transfer copyright or ownership, and is a limited license to use in accordance with these and other conditions set by B&P. The Contract Documents do not require the Contractor to use the model to prepare drawings in electronic format for use during construction, or the use in any way of BIM or CAD systems. The Contractor is not permitted to make alterations to the design model and/or the information contained therein without prior approval from B&P.

2. The model and the information contained is provided as is, the Revit Version 2014 (or earlier version as required by the project) format used by B&P. The model is provided without warranty or guaranty of compatibility with the Contractor's software or hardware systems. Further, the Contractor acknowledges data stored within the model can be altered, wither intentionally or unintentionally, by transcription, machine error, environmental factors, duration, and method of storage, and/or computer operators.

3. The model, and the information contained therein is provided for the Contractor's convenience only, is not a Contract Document and does not relieve the Contractor from the requirements of the Contract Documents. The information provided in the model may not reflect the Contract Documents in all areas and the Contractor will be required to verify where changes have occurred. Also, field verification of existing and as-built conditions are required as part of a submittal process as applicable per project requirements. The official Contract Document set will be used as the precedent and authoritative document, and, in comparison with electronic files, shall supersede any discrepancies, omissions, or errors shown on the electronic files.

4. The design model may contain information provided by others. B&P cannot guarantee or warrant the accuracy and completeness of information provided by others.

5. The information provided in the model is only diagrammatic reflecting design intent. Contract Documents require that the work and coordinated shop drawings reflect actual field verified conditions with actual equipment/duct sizes, utility locations, and related site/project conditions.

6. The Contractor accepts responsibility for ensuring all persons, including sub-contractors, using the model complies with the requirements and limitations in using the information provided to them.

Further, the use of the model is limited solely to this project. Use of the model or contents within on other projects or on other applications by the Contractor is expressly prohibited.

7. This Hold Harmless Agreement shall be attached to and transmitted with the design model at all times so that all those that the Contractor allows to have access are bound by the terms of this Agreement.

ACKNOWLEDGEMENT

1 By accepting the design model and the above stipulations, the Contractor and its agents, employees, Subcontractors of any tier, material suppliers or any others that Contractor allows to access the model agrees to defend, indemnify and hold harmless the Owner and Bridgers & Paxton Consulting Engineers, Inc., their agents, employees against all claims, liabilities, damages, losses, expenses and costs (including expert and attorney's fees) (Claims) arising from, relating to or resulting from their use of the design model (BIM).

ACCEPTED:
CONTRACTOR REPRESENTATIVE

Authorized Signature: _____
Title: _____
Date: _____

BRIDGERS & PAXTON CONSULTING ENGINEERS

Authorized Signature: _____
Title: _____
Date: _____

SECTION 23 0503 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the HVAC work specified herein under Division 23.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplemental General Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 TRENCHING AND BACKFILLING

A. General Excavation: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not required or suitable for backfill shall be removed and wasted. Berming and grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as required for the protection of the work and for the safety of personnel.

B. Trench Excavation: Trenches shall be of adequate width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable and safe for workmen. The bottom of the trenches shall be accurately graded and bedded to provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and bedded in order that the pipe rests upon the

prepared bottom for as nearly its full length as practicable. Care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated on the drawings or specified. Overdepths in the rock and common excavation shall be backfilled with coarse sand, fine gravel, or otherwise suitable material. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable materials, as hereinafter specified.

C. The Contractor shall move trucks and equipment on prescribed roads and keep the roads free from mud, dirt and spillage.

D. If additional material is needed for fill on the project, it shall be furnished by the Contractor.

E. Bracing and Bulkheading: In all excavation work the Contractor shall provide necessary underpinning, bracing, or bulkheading to safeguard the work, the present structures, workmen, the public, and the property, and shall assume all responsibility in connection therewith.

F. Backfilling: The trenches shall not be backfilled until all required pressure tests are performed and until the utilities as installed conform to the requirements specified. The trenches shall be carefully backfilled with materials approved for backfilling; free from large clods of earth or stones. The entire depth of trench shall be backfilled in layers, and each layer shall be spread evenly, wetted to optimum moisture and thoroughly mixed to uniform consistency and compacted to the required maximum density obtainable as the same soil, as determined by ASTM D698.

G. All imported fill required under this section will be furnished by the Contractor. Imported fill will be base course material approved for use by the State Highway Department.

H. Fill material shall be free from trash, lumber or any type of debris which may be detrimental to producing the required density in the fill.

I. The earth beneath all sidewalks and concrete slabs shall be backfilled and compacted to at least 8" below any gravel or sub-base material before the placement of gravel or other base material and shall be coordinated with requirements contained within Division 2.

J. All piping not encased in concrete shall be bedded in sand or fine gravel, without rocks or other foreign material. Bedding material shall be placed around the pipe in accordance with manufacturer’s recommendations. The bedding material shall be distributed around pipe to assure full consolidation.

K. In grass and planted areas, the Contractor shall backfill his excavation to approximately 8" below finished grade. Contractor shall coordinate backfill requirements contained in Division 2.

L. The Contractor shall protect from damage all existing underground utilities and utility tunnels indicated on the Contract Drawings. Any damage to such existing utilities or utility tunnels shall be repaired by the Contractor without additional costs to the Owner.

M. Provide density test for trench, backfill in accordance with Division 2 requirements

END OF SECTION 23 0503

SECTION 23 0504 – PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures furnished under Division 23 shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Piping system materials shall be furnished as specified under the Sections describing the various piping systems. Pipe fittings shall be compatible with the piping systems in which they are installed.

B. Pipe fittings for steel piping systems shall be weld, or screwed. Butt weld fittings shall be manufactured by Weld-Bend, Laddish, or equivalent, standard or extra strong as specified in the applicable Sections of this Specification, conforming to ANSI Standard B16.9. All 900 weld elbows shall be long radius unless otherwise specified. Wherever tee connections are required in the piping system, manufacturer's straight or reducing tees shall be utilized. The use of fittings formed from welded pipe or pipe sections will not be permitted. Forged steel "Weld-O-Lets", "Branch-O-Lets", and "Thred-O-Lets", as manufactured by Bonney Forge or equivalent, may be utilized for welded branch and tap connections up to one-half the size of the main. Forged steel

half-couplings conforming to ANSI B16.11 may be used for drain, vent and gauge connections. Flanges shall be forged steel weld neck or slip-on, raised face, Class 150 or 300 as specified in the applicable Sections of this Specification with full face or ring type non-asbestos gasket material suitable for the application.

C. Socket weld fittings shall be Schedule 40, 2000 pound or Schedule 80, 3000 pound construction, as specified in the applicable Sections of this Specification, conforming to ANSI B16.11, as manufactured by Grinnell or equivalent.

D. Screwed fittings shall be Class 150 standard or Class 300 extra heavy, black or galvanized, malleable iron or cast iron, as specified in the applicable Sections of this Specification, as manufactured by Grinnell or equivalent. Screwed malleable iron fittings shall conform to ANSI B16.3 and cast iron screwed fittings shall conform to ANSI B16.4. Bushing reduction of a single pipe size or use of close nipples will be permitted.

E. Pipe fittings for copper piping system shall be wrought copper conforming to ANSI B16.22. Cast brass fittings conforming to ANSI B16.23, may be utilized for sanitary drainage, waste and vent systems, HVAC gravity condensate drainage system, and other non-pressure applications.

F. Bronze flanges, Class 125 and Class 150, shall conform to ANSI B16.24.

G. Cast iron fittings for cast iron sanitary soil, waste, and venting piping systems shall be as specified in Division 22.

H. Ductile iron fittings for ductile iron water service piping systems shall be as specified in Division 22.

2.2 FLOOR, WALL AND CEILING PLATES

A. Where uncovered, exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass escutcheon plates. Plates shall be large enough to completely close the hole around the pipe, and shall be not less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.3 UNIONS

A. Piping 2-1/2" and larger shall be provided with bolted flange union connections. Weld flanges and bolting shall conform to ANSI B16.5. Bronze flanges shall conform to ANSI B16.24. Flange class shall be as specified in the applicable Sections of the Specifications.

B. Malleable iron grooved joint unions with brass to iron seats, Class 125, 250, or 300, as required by the application and compatibility requirements with the piping system fitting classification, conforming to MSS SP-77 and ANSI B16.39, shall be provided in piping systems 2" and smaller. Copper unions conforming to ANSI B16.22 shall be provided in copper piping

C. Systems. Union connections shall be installed at all coils, control valves, equipment connections, and at other locations shown on the drawings, and required for proper system operation and maintenance.

2.4 DIELECTRIC FITTINGS

A. Dielectric insulating fittings shall be provided to connect dissimilar metals, such as copper tubing to ferrous metal pipe. Connections 2" and smaller shall be threaded dielectric union conforming to ANSI B16.39. Connections 2-1/2" and larger shall be flange union with dielectric gasket and bolt sleeves, conforming to ANSI B16.42. Insulating fittings will not be required between bronze valves and copper piping, unless otherwise specified.

2.5 PIPE HANGERS AND SUPPORTS

A. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications. Pipe hangers shall be Grinnell, B-Line, Erico, or equivalent.

B. No attempt has been made to show all required piping supports in all locations, either on the drawings or in the details. The absence of pipe supports and details on any drawing shall not relieve the Contractor of the responsibility for furnishing and installing proper hangers and supports throughout.

C. Piping hangers shall be spaced on the scheduled maximum spacing and shall have hangers not more than one foot from each elbow and other changes in direction or elevation. Provide additional hangers and supports at valves, strainers, in-line pumps adjacent to flexible connections, and other required heavy components. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and miscellaneous steel supports as may be required to distribute the piping system load over multiple structural members where required or directed. Maximum allowable spacing for steel and copper piping, other than fire protection piping, shall be as scheduled in Table No. 1.

TABLE NO. 1

MAXIMUM SUPPORT SPACING FOR STEEL
AND COPPER PIPING SYSTEMS

Steel Piping	Maximum Spacing
1/2"	5'-0"
3/4" and 1"	6'-0"
1-1/4" through 2"	8'-0"
2-1/2" through 6"	10'-0"
8" through 12"	12'-0"

Copper Piping	Maximum Spacing
1/2"	5'-0"
3/4" and 2"	6'-0"
2-1/2" through 4"	8'-0"
5" and larger	10'-0"

D. Round rods supporting the pipe hangers shall be of the minimum dimensions as scheduled in Table No. 2. Hanger rods shall be hot-rolled steel, ASTM A-36 or A575, galvanized, all-thread. Provide for controlling level and slope by turnbuckles or other approved means of adjustment and incorporate locknuts.

TABLE NO. 2

HANGER ROD SIZE FOR PIPE HANGER SUPPORTS

1/2" to 2" pipe	3/8" rod
2-1/2" to 3" pipe	1/2" rod
4" to 5" pipe	5/8" rod
6" pipe	3/4" rod
8" to 12" pipe	7/8" rod
14" and 16" pipe	1" rod
18" and 20" pipe	1-1/4" rod
24" and 30" pipe	1-1/2" rod

E. Cast iron soil, waste and vent piping shall be provided with steel clevis type hangers. Grinnell Fig. 590 at each pipe joint and at each fitting.

F. Hanger spacing for plastic piping system support shall be as scheduled below in Table No. 3 for PVC and CPVC and Table No. 4 for PVDF piping, based on pipe full of liquid with specific gravity of 1.0. See Table No. 5 for specific gravity correction factors. Piping may be continuously supported with a "V" or "U" shaped support made of metal or heat resistant approved plastic material. Hanger supports shall be in accordance with piping system manufacturer's recommendations.

TABLE NO. 3A
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS

SCHEDULE 40 PVC - MAXIMUM SPACING OPERATING TEMPERATURE (DEGREE F)

Size	60 & less	80	100	120	140	160	180	200
1/2" and 3/4"	5.5	5	4.5	4	3	3	3	2.5
1" and 1-1/4"	6	5.5	5.5	4.5	3.5	4	3.5	3
1-1/2" and 2"	6	6	5.5	4.5	3.5	4.5	4	3.5
2-1/2" and 3"	7.5	7	6.5	5.5	4.5	5.5	5	4
4"	8	7.5	7	6	4.5	6	5.5	4.5
5" and 6"	8.5	8	7.5	6.5	5	7	6	5
8"	9.5	9	8.5	7	5.5	7.5	6.5	5.5
10"	10	9	8.5	7	5.5	--	--	--
12"	10.5	10	9	8	6	--	--	--

TABLE NO. 4
MAXIMUM SUPPORT SPACING FOR PVDF PIPING SYSTEMS

SCHEDULE 80 PVDF - MAXIMUM SPACING OPERATING TEMPERATURE (DEGREE F)

Size	70 & less	100	140	180	200	250
1/2"	3	3	2.5	2.5	2	2
3/4"	3	3	3	3	2.5	2.5
1"	3.5	3	3	3	2.5	2.5
1-1/4"	4	3.5	3.5	3	3	3
1-1/2"	4.5	4	4	3.5	3.5	3
2"	5.5	5	4.5	4	3.5	3.5
2-1/2"	5.5	5	4.5	4.5	4	3.5
3"	5.5	5.5	5	4.5	4	4
4"	6	6	5.5	5	5	4.5

TABLE NO. 5
SPECIFIC GRAVITY CORRECTION FACTOR FOR PLASTIC PIPING SYSTEMS

Specific Gravity:	1.0	1.1	1.2	1.4	1.6	2.0	2.5
Correction Factor:	1.0	0.98	0.96	0.93	0.90	0.85	0.80

G. Fire protection system shall be supported in strict accordance with the requirements contained in the applicable NFPA pamphlets and as specified in Division 21, Fire Suppression Systems.

H. Hangers, clamps and other support materials in contact with copper piping shall be copper or copper plated to prevent electrolysis. Hangers for copper piping shall be copper plated adjustable ring type Grinnell Fig. CT-269, adjustable swivel ring, Grinnell Fig. CT69, Fig. CT- 65 or adjustable clevis type or equivalent. Provide minimum 10 mil plastic wrap around copper pipe at any ferrous point of attachment including trapeze hangers, clamps, and other supports.

I. Hangers for steel shall be steel clevis type hangers, Grinnell Fig. 260 or equivalent.

J. Where piping is installed side by side, the Contractor may support the piping utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be galvanized steel channel, not less than 1-1/2" x 1-1/2" x 12" gauge, or Unistrut. Contractor shall provide heavier steel members as required for the load to be supported and the distance span. Trapeze hangers shall not be utilized for steam and condensate piping, fire and sprinkler piping and plumbing drain waste and vent piping. Hanger rods shall be as specified above, properly sized for the load supported but not less than 5/8" diameter. Un-insulated copper piping shall be isolated from the steel trapeze. Individual pipe shall be guided on the horizontal member at every other hanger point with 1/4" U-bolt fabricated from steel rod. Provide full circle galvanized sheetmetal insulation shield for insulated piping at trapeze hangers with U-bolt guide and galvanized sheetmetal insulation half-shield at other trapeze hangers. Insulation shield shall be 18 gauge minimum, Grinnell Fig. 167 or equivalent.

K. Where shown on the drawings and as required for the proper control of the system expansion and contraction, and for heating hot water, steam and condensate piping within the building and in

utility tunnels/trenches provide rolled type supports. Roller hangers shall be Grinnell Fig. 181 or equivalent and roll support for trapeze hangers and pipe racks shall be Grinnell Fig. 271, Erico, or equivalent complete with base plate.

L. Special piping supports including tunnel support racks, wall support racks, floor mounting pedestal type supports shall be provided as indicated on the drawings, and as required for the proper support for the piping systems.

M. Supports for special piping systems including refrigeration piping shall be provided as recommended by the pipe manufacturer and as specified in the applicable Sections of this Specification.

N. Vertical piping shall be supported at each floor level by means of riser clamps, Grinnell Fig. 261 and Fig. G-121, Erico, copper clad for copper piping systems, or equivalent. Proper allowance for the expansion and contraction of the vertical risers shall be provided. Contractor shall submit shop drawings indicating proposed method for support and control of expansion and contraction of vertical piping.

O. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.

P. All insulated piping systems specified in Section 22 0700, Plumbing Insulation and Section 23 0700, HVAC Insulation, shall be provided with individual hangers sized to encircle the insulation. Hangers for insulated domestic water piping and roof drain piping systems may be installed under the insulation. See applicable sections for insulation thickness requirements. The specified piping systems where supported by means of trapeze hangers shall not rest directly on the trapeze horizontal members. The insulation at hangers and trapeze hangers shall be protected by means of insulation shield, Grinnell Fig. 167, Erico, or equivalent. Grinnell Fig. 160, Erico, or equivalent, curved steel pipe saddle, shall be provided at roll hangers. Contractor shall provide section of high density calcium silicate insulation or thermal hanger shields as manufactured by Pipe Shields, Inc., or equivalent, at all insulation piping system hanger and support points for piping 1-1/2” or larger.

Q. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Architect. The Contractor shall provide concrete inserts in the building construction at the time the concrete is poured and hangers shall be attached to these inserts. Self-drilling expansion anchors, Federal Specification FF-S-325, may be used in concrete construction not less than 4" thick. Applied load shall not exceed manufacturer's approved ratings. Power driven fasteners may be used in existing concrete or masonry not less than 4" thick where approved by the Architect. Attachment to steel construction shall be by means of beam clamps Grinnell Fig. 131, Erico, C-clamps Grinnell Fig. 86, Erico, or equivalent may be utilized for attachment of light loads as approved by the Structural Engineer. Attachment to wood construction shall be by means of wood screws or lag bolts.

2.6 PIPE SLEEVES

A. Pipe sleeves in concrete and masonry construction, footings and beams shall be Schedule 40 black steel pipe through 10”, standard wall thickness for sizes 12” and larger, ASTM A 53, A 106, or A 120.

1. For sleeve installation below grade in cast in place concrete wall or floor and masonry construction, sleeves shall be GPT type WS sleeves with minimum 2” water-stop collar or equivalent. The sleeves shall be provided free of welding slag. The water stop collar shall be welded all around on both sides to the sleeve at the point on the sleeve that positions it at the midpoint of the wall. Sleeve shall be primed inside and outside with Sherwin Williams Water Base Red Primer, or approved equivalent.

B. Pipe sleeves in gypsum board construction shall be galvanized steel metal, minimum 24 gauge; round tube closed with welded longitudinal joint and flanges on both sides.

C. Pipe sleeves shall be furnished and set by the Contractor and they shall be responsible for their proper and permanent location. Piping will not be permitted to pass through footings, beams or ribs except with written consent of the Architect.

D. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through gypsum board stud walls, concrete, and masonry construction and at all fire and smoke rated walls and partitions.

E. Where insulated piping is installed, calcium silicate inserts to match the insulation thickness and extending 1" past the sleeve on both ends, shall be provided.

F. Sleeves shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed.

G. Pipe sleeves in floors shall extend 2" above finished floor in chases and equipment room areas unless otherwise approved by the Architect. Openings between piping and sleeves shall be made watertight with plastic cement installed to a minimum depth of 2".

H. Un-insulated piping passing through fire walls, smoke wall, sound control walls and air plenum separations shall be sealed airtight to the adjacent construction by means of UL approved fire stop sealant materials.

I. Insulated piping passing through fire walls and smoke walls shall be provided with Calcium Silicate pre-formed pipe insulation of thickness to match adjacent piping, extending minimum 1-inch beyond sleeve in each direction.

1. For penetrations through concrete or masonry walls/floors, the space between the piping sleeve and insulation shall be sealed airtight with UL approved firestop sealant and packed with minimum 4” thickness mineral wool (minimum 4 pcf density) tightly packed and recessed to accommodate sealant.
2. For penetrations through gypsum board wall construction, both sides of the annular space between the insulation and sleeve shall be sealed with UL approved firestop sealant.

J. Penetrations of gypsum board sound walls and air plenum separators shall be caulked airtight with an approved UL firestop sealant.

2.7 PIPE SLEEVE SEAL SYSTEMS

A. Provide pipe sleeve seal systems by one of the following:

1. Link-Seal Modular Wall Penetration Seal as manufactured by GPT.

2. Metraflex Company
3. Proco Products, Inc.

B. Description: Modular sealing element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Plastic, reinforced nylon polymer
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

C. Pipe sleeve seal system shall be utilized at all exterior wall penetrations.

D. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Provide and erect, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All piping shall be so installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining. Water piping shall be pitched a minimum of 1" per 50 feet for draining. Steam piping shall be continuously pitched in the direction of flow a minimum of 1" per 20 feet.

3.2 JOINTS

A. Caulked Joints: Caulked joints in hub-and-spigot piping and vent piping shall be packed firmly with white oakum, "Sealite No. 110," or hemp and caulked with pure molten lead not less than 1" deep. Resilient molded gasket joints or "Ty-Seal" may be used in lieu of lead and oakum for sanitary soil, waste and vent piping. No-hub pipe and fittings will be accepted with the exception that no-hub pipe and fittings shall not be allowed for buried installation.

B. Screwed Joints: Shall have American Taper pipe threads. Ream pipe ends and remove burrs after threading. Make up joints using Teflon tape or other approved compound applied to the male threads only.

C. Solder Joints: Copper tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a non-corrosive paste flux and solid 95-5 tin-antimony wire solder, unless otherwise specified. Cored solder will not be permitted. 50/50 lead solder shall not be permitted for any applications.

D. Welded Joints: On black steel piping 2-1/2" and above in size, the joints may be welded. Welding shall be done using either gas or electric welding equipment. Certified welders shall be used. Welders shall be certified in accordance with Section IX of ASME Boiler and Pressure Vessel Code, latest edition. All pipe surfaces shall be thoroughly cleaned before welding. Each joint shall be beveled before being welded. Piping shall be securely aligned and spaced, and the width of circumferential welds shall form a gradual increase in thickness from the outside surface to the center of the weld. All fittings used in the welded piping systems shall be standard ASA fittings, and shall be of standard pipe thickness. The Contractor shall provide a fireproof mat or blanket to protect the structure and adequate fire protection at all locations where welding is done. The use of fittings formed from welded pipe sections will not be permitted.

E. Flanged Joints: Flanged joints shall conform to the American Standard for cast iron flanged pipe fittings, Class 125, 150 or 300 as specified in the applicable Sections of these specifications. Gaskets shall be full face or ring type, non-asbestos, suitable for the service on which used.

3.3 PUMP AND EQUIPMENT CONNECTIONS

A. All piping connecting to pumps and other equipment whether connected utilizing flexible connectors or with solid pipe connectors, shall be installed without strain at the pipe connection of the equipment. The Contractor shall be required, if so directed, to disconnect piping to demonstrate that piping has been so connected.

3.4 EXPANSION AND CONTRACTION

A. The Contractor shall make all necessary provisions for expansion and contraction of piping with offsets or loops and anchors as required to prevent undue strain. Contractor shall provide shop drawings for proposed method and arrangement for control of expansion and contraction of piping. See Section 23 0505 for expansion joints, expansion compensators, pipe guides and pipe anchors.

3.5 PROTECTIVE COATINGS

A. All underground steel pipe shall be wrapped with "Scotchwrap" No. 50 tape or equivalent, to give not less than two complete layers on the entire underground piping system, or piping shall have X-Tru-Coat factory applied plastic protective covering.

3.6 FLUSHING, DRAINING AND CLEANING PIPE SYSTEMS

A. The Contractor shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

B. See applicable HVAC piping system specification sections for chemical cleaning of piping systems.

3.7 TESTING

A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than 150% of the maximum service pressure which the piping systems will be required to handle. Piping system tests shall be as specified in the applicable sections of this Specification. All tests shall be witnessed and approved by the Architect.

B. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests. To perform tests, all lines shall be flushed and cleaned.

C. All safety measures required by codes or ordinances or reasonably applicable to the situation shall be provided by the Contractor in conjunction with the testing of the piping systems.

D. Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Underground piping may be partially backfilled prior to pressure test when required for application of the test except that joints shall remain exposed until after the test. Tie rods, clamps etc., shall be in place and fastened.

E. Tests shall not be used to establish pressure ratings.

F. Protect all piping and equipment against over pressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.

G. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 600F. Note that some applicable codes may require testing above a specified minimum temperature.

H. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test. Also remove all items such as orifice plates which might trap air in a system to be hydrostatically tested. Disconnect all instruments and air lines where copper tubing starts.

I. Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

J. During hydrostatic testing of lines, provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

END OF SECTION 23 0504

SECTION 23 0505 – PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0523, Valves.

1.3 SUBMITTAL DATA

A. Furnish complete submittal data for all piping specialties including manufacturer’s specifications, performance characteristics, ratings, installation instructions, certifications and approval of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

2.1 STRAINERS

A. Strainers suitable for the application shall be furnished and installed on the high pressure side of pressure reducing valves, pressure regulating valves, suction side of pumps, inlet of indicating and control instruments and equipment subject to sediment damage, and as shown on the drawings. Strainers shall be "Y"-type unless basket strainers are indicated. Tee-type strainers will not be accepted. Strainer element shall be removable without disconnecting piping. Screens shall be Type 304 stainless steel with 1/8 inch perforations for water service, and 1/16 inch perforations for steam, air and gas services. Every strainer shall be provided with a blow-off connection not less than 1/2" NPT and provided with a ball valve the full size of the strainer outlet tapping.

Strainers located outside of mechanical equipment rooms and above ceilings shall be provided with hose connection and cap on the outlet of the blowoff valve. Strainers shall be Spirax Sarco, Armstrong, Febco, Grinnell, Hoffman, Keckley, Metraflex, Mueller, Yarway, or equivalent.

B. Strainers 2" and under for copper piping systems shall be threaded connection, bronze body, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco BT or equivalent.

C. Strainers 2" and under for steel piping systems shall be threaded connection, bronze body, as specified above or cast iron body as specified herein, except all strainers in galvanized steel domestic water systems shall be bronze body. Cast iron strainers shall be threaded connection, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco IT or equivalent.

D. Strainers 2-1/2 inches or larger shall be standard flanged connection ANSI-125, cast iron body, suitable for steam, oil , gas, and liquid service, 125 maximum working pressure at 353o F maximum temperature, Sarco CI-125, or equivalent.

E. Basket strainers 2" and larger shall be standard flanged ANSI-125, cast iron body bolted cover, Type 304 stainless steel screen, suitable for steam or liquid service, 125 maximum working pressure at 353oF maximum temperature, Sarco 528-B-125, or equivalent.

2.2 PRESSURE GAUGES

A. 2.5-inch glycerin filled, SS case, 1.5% accuracy, dual scale (PSI & KPA), bronze bourdon tube and 0.25-inch NPT connection, brass snubber with properly selected filter disc for the application, and needle valve with knurled brass or ABS plastic handle. Provide multiple needle valves where a single pressure gauge is used to measure pressure at multiple points. Provide siphon for steam gauges. Winters, Weiss, Marshalltown, Ashcroft, Trerice, Weksler, or equivalent.

B. Select pressure range as indicated on the drawings, or if not indicated select so that the normal operating pressure is approximately 50% of the scale range. Provide compound and vacuum gauges where required by the application.

C. Install gauges so they are easily readable from normal operator level. Where the sensing location is not convenient to the operator, install the gauge and needle valves at a location easily read from normal operator level, extend piping from there to the sensing point on the main pipe, and provide a ball valve for isolation at the main. In addition, provide drain and vent valves to facilitate removing air and water from the sensing line.

2.3 THERMOMETER AND THERMOMETER WELLS

A. Either liquid filled or digital type, vari-angle, 3-1/2" stem for pipe sizes through 6" and 6" stem for pipe sizes 8" and larger, dual scale (degrees F & C), separable brass socket, extension neck where installed in insulated piping, and accuracy 1% of range. Winters, Weiss, Moeller, Trerice, Weksler, Duro, or equivalent.

1. Liquid Filled Type: 9" case, straight form, V-shaped, high pressure die cast aluminum, baked enamel finish, with heavy glass-protected front firmly secured with spring action, and organic liquid filled magnifying lens. Winters 9IT or approved equal.
2. Digital Type: May be used both indoors or in outdoor locations not exposed to sunlight, high impact ABS plastic housing, suitable for operation at 16 Lux. Winters 9IT or approved equal.

B. Ranges: Provide the following ranges except where otherwise indicated:

Heating Water	30-240 degrees F
Chilled Water, Condenser Water, Domestic Cold Water	0-120 degrees F
Domestic Hot Water	30-180 degrees F

2.4 MANUAL AIR VENTS

A. Provide manual air vents at locations indicated on the drawings, at the high point of all liquid piping system and as otherwise required for proper air elimination and liquid circulation.

B. Manual air vents shall be 1/2" brass ball valves as specified in Section 23 0523. Provide brass hose connection and plug on valve outlet.

2.5 AUTOMATIC AIR VENT

A. Provide automatic air vents for all separators, at the high point of all hydronic systems and at locations indicated on the drawings. Automatic air vents shall be 3/4" size, minimum. Provide manual shut-off ball valve between automatic air vent and piping system. Automatic air vents shall be float type, 150 PSIG maximum working pressure, 3/4" NPT system connection, Amtrol Model No. 720, Taco, Armstrong, Watson-McDaniel, Hofmann, or equivalent.

2.6 MANUAL DRAIN VALVES

A. Provide manual drain valves at locations indicated on the drawings, at the low points of all liquid piping systems, and as otherwise required for proper draining of systems. Manual drain valves shall be sized as shown on the drawings but not less than 3/4" size, brass ball valve, as specified in Section 23 0523. Pipe discharge from drain valves to floor drain, floor sink, or as otherwise directed for indirect discharge into sanitary sewer system. For drain valves located above ceiling or in location outside mechanical equipment areas provide brass hose connection and cap for valve discharge.

2.7 TEMPERATURE AND PRESSURE TEST PLUGS

A. 0.25 or 0.5-inch NPT with brass body, EPDM core, and brass gasketed cap. Winters, Peterson, or approved equal. Supply one pressure/temperature test kit with two 4" Duro #105 pressure gauges of 1% accuracy and ranges as required by application; and two 2" Tel-Tru #39R Bi-metal thermometers with 8" stem, 1% accuracy, and ranges as required by the applications; and a protective carrying case.

2.8 FLOW BALANCE VALVE

A. Furnish and install calibrated balance valve equivalent to Bell and Gossett "circuit-setter," Griswold, Taco, Armstrong, or equivalent at locations indicated on the drawings. Balance valves shall be brass or cast iron body, NPT or sweat connections through 3" size and flanged connections above 4" size, 125 PSIG working pressure minimum. Balance valve shall be equipped with two brass readout valves with integral EPT insert and check valve designed to minimize system fluid loss during balancing and monitoring process. Each valve shall be provided with a calibrated nameplate permitting accurate system balance. Flow balance valves shall be not less than full line size with maximum pressure drop of 10 feet.

2.9 WATER FLOW MEASURING DEVICES

A. Furnish and install cast iron wafer type flow meter equivalent to Bell & Gossett "OP-Series," Griswold, Taco, Armstrong, or equivalent at locations indicated in the drawings. Flow meters shall be equipped with two brass readout valves with integral EPT insert and check valve designed to minimize system fluid loss during monitoring process. Flow meter shall be furnished with a calibrated nameplate specifying the flow range through a range of differential pressures. Water flow measuring devices shall be not less than full line size with maximum pressure drop of 10 feet.

2.10 AUTOMATIC FLOW LIMITING VALVES

A. To maintain constant flow within 5 percent over a range of 2-32 psid. Bronze or cast iron body, stainless steel cartridges, two pressure readout ports with quick disconnect valves and caps, SS identification tag marked with rated flow. Valves through 2 inch size shall be threaded connection, valves over 2 inches shall be wafer type; 150 psig rated. Supply one readout kit including flow meter, hoses and flow charts all contained in carrying case. Size valves for required flows. Griswold, FDI, or approved equal.

2.11 FLEXIBLE CONNECTORS

A. Furnish and install flexible connectors at locations indicated on the drawings and at all piping connections associated with equipment mounted on or hung from vibration isolators. Flexible connectors shall be constructed of multiple ply nylon cord fabric and neoprene, operating pressure 150 PSIG at 220OF through 12" size and operating pressure of 125 PSIG at 220OF for sizes 14" through 24". Provide butyl or Hypolon liner and applications with fluid temperatures in excess of 225OF.

B. Flexible connectors shall be single or twin sphere with Class 150 flange connections for sizes 2-1/2" and larger and threaded connections with galvanized female unions for sizes 3/4" through 2". Mason Industries MFTCR, Hyspan, Metra-Flex, Keflex, Proco, or equivalent. Flexible connectors required for outdoor installation shall be braided brass type.

C. Installation of flexible connectors shall be in strict accordance with manufacturer's recommendations. Spacing between piping system flanges shall be based on the flexible connector's expanded length corresponding to the system's operating pressure. Control rods or cables shall be provided for units installed in unanchored applications where system operating

pressure and dynamic forces exceeds manufacturer's recommendations for unrestrained installations.

2.12 EXPANSION TANK

A. Furnish and install diaphragm type, pre-pressurized, ASME code construction 125 PSIG working pressure, and expansion tank in horizontal or vertical arrangement as shown on the drawing and required for equipment space allocation. Properly sized expansion tanks shall be provided for all closed circuit hydronic systems. Connect expansion tank to the low pressure side of the piping system with 3/4" minimum line size; provide quarter turn ball valve with handle removed for manual isolation valve. Contractor shall field verify expansion tank air charge and re-charge as required to maintain correct system pressurization and tank expansion volume. Expansion tanks shall be Amtrol, Woods, Armstrong, Taco, or equivalent.

2.13 AIR SEPARATOR

A. Furnish and install air separator, inline or tangential type as shown on the drawings for all closed circuit hydronic system. Inline air separators shall be fabricated of steel or cast iron, 125 PSIG working pressure. Tangential type air separators shall be ASME code construction for 125 PSIG working pressure and shall be furnished with internal perforated stainless steel air collection tube, bottom blow down connection and removable stainless steel strainer element with 3/16" perforations and free area of not less than five times the cross-sectional area of the connecting piping.

B. Each air separator shall be provided with an automatic air vent, 3/4" size, Amtrol Model No.

C. 720 or equivalent, with manual shut-off ball valve between automatic air vent and air separator.

D. Air separators shall be full line size and installed at the high point of the piping system unless otherwise indicated in the drawings.

E. Air separators shall be Amtrol, Woods, Armstrong, Taco, or equivalent.

2.14 WATER PRESSURE REGULATING VALVES

A. Furnish and install water pressure regulating valves, Watts U5B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for water makeup to all hydronic systems and at other locations as shown on the drawings. Water pressure regulating valves shall be brass body, union inlet with integral strainers, 300 PSIG maximum working pressure, with built-in thermal expansion bypass.

B. For high water capacity applications provide Watts 2235B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent.

C. Provide high or low pressure range depending on application requirements. Set pressure shall be as shown on the drawings, or as required to provide a minimum system pressurization of 12 PSIG at the system's highest point for closed circuit hydronic systems, or as recommended by equipment manufacturers.

2.15 WATER PRESSURE RELIEF VALVES

A. Furnish and install ASME labeled, National Board Stamped, water pressure relief valves, Watts Series 174A or 740, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for relief of all water makeup to all closed circuit hydronic systems. Properly sized relief valves shall be provided where required for over-pressure protection on heat exchangers, converters, boiler, and pressure vessels, and other locations as shown in the drawings.

B. Relief valves shall be sized for the full system heating capacity, to match the makeup capacity, or as otherwise required to protect the system from over-pressure conditions. Relief valves shall be factory pre-set for maximum pressure rating shown in the drawings, or for approximately 125% of the system operating pressure, but in no case shall the relief valve setting exceed the maximum safe operating pressure of the system and system components and equipment.

2.16 WATER TEMPERATURE AND PRESSURE RELIEF VALVES

A. Furnish and install ASME labeled, National Board stamped water temperature and pressure relief valves, Watts, Cash, or equivalent, for all domestic water heaters, domestic water storage tanks, and other locations indicated in the drawings.

B. Water temperature and pressure relief valves shall be sized for the full system heating capacity at 210oF maximum operating temperature and shall be furnished with the required valve thermostat tube extension length.

2.17 WATER REDUCED PRESSURE BACKFLOW PREVENTERS

A. Furnish and install water reduced pressure backflow preventer, as approved and accepted by the City of Las Cruces, State of New Mexico, Febco Model 825Y, Hersey, Beeco, Watts, or equivalent. 3/4" minimum size shall be provided for water makeup to all required HVAC systems. Backflow preventers shall be provided at other locations as shown on the drawings. Reduced pressure backflow preventer shall include two shut-off gate or ball valves, two check valves, pressure relief valve, and four test cocks. Units shall be factory assembled, tested and certified. Units 2" and smaller shall be brass body, threaded connections, 175 PSIG maximum working pressure. Units 2-1/2" and larger shall be provided with flanged connections.

B. Water reduced pressure backflow preventer installation shall be in accordance with manufacturer's instructions and City of Las Cruces, State of New Mexico requirements for access for testing and inspection.

C. See Division 33, for backflow protection associated with site water supply system.

D. See Division 22 for backflow protection associated with building domestic water supply system.

E. See Division 21 for backflow protection associated with building fire protection system.

F. Backflow protection devices associated with landscaping and irrigation systems shall be furnished and installed under the Site Work sections of these specifications.

2.18 FLOW METERS AND INSTRUMENTATION

A. Steam condensate and BTU meters and instrumentation shall be furnished and installed as shown on the drawings and specified in Division 25.

2.19 SOLENOID VALVES

A. Furnish and install electric solenoid valves as shown on the drawing and as required for the operation of the mechanical systems. Solenoid valves shall be 115 volt single phase, 60 Hz, two-way arrangement, two positions with normally open or normally closed arrangement as required of the application. Solenoid valves associated with safety protection of systems including freeze-protection, drain down, etc. shall be provided such that in the event of a power failure the system shall fail to a safe operating condition. Solenoid valves shall be as manufactured by ASCO, Armstrong, Honeywell, Metrex, or equivalent.

B. See Section 23 0500, Common Work Requirements, and Section 23 0549, HVAC and Electrical Installation Coordination, for requirements associated with electrical control and power wiring for solenoid valves. Furnish hazardous duty enclosure where required by the application.

2.20 FLOW SWITCHES

A. Furnish and install flow switches where required for protection and/or monitoring of mechanical equipment including water chillers, boilers, pumps, etc. and as otherwise shown on the equipment schedule, and the drawings.

B. Flow switches shall be either paddle type or differential pressure type as required by the application and as shown on the drawings, except differential pressure type flow switches shall be utilized for water chillers and other applications where minor pressure fluctuation could cause nuisance tripping of equipment operation.

1. Paddle type flow switch shall be McDonnell and Miller Model FS7-4 Series, or equivalent designed for industrial duty, brass body and trim, 300 PSIG maximum working pressure, paddle size as required for application, single pole double throw switches, with electrical rating of 7.4 full load amps at 115 VAC. Provide hazardous duty enclosure where required by the application. Flow switches shall be installed in a horizontal pipe with inlet and outlet conditions necessary to provide trouble-free operation.
2. Differential pressure flow switch shall be Honeywell Model 406 Series or equivalent, adjustable pressure differential setting, dustproof mercury switch enclosure, 1/4" NPT bellows connections, single pole, single throw switch, with electrical rating of 7.2 full load amps at 115 vac. Differential pressure switches shall be properly supported on the equipment controlled or wall mounted adjacent to the equipment or piping system.

2.21 EXPANSION JOINTS

A. Furnish and install corrugated bellows expansion joint, Hyspan Series 1500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, self-equalizing, 150 PSIG working pressure at 850oF, Class 150 ASA flange connections 1-1/2" size and above, single or dual center base configuration as shown on the drawings, constructed of corrugated Type 304 or 321 stainless steel, ring controlled, with

integral stainless steel or Monel sleeve, and removable carbon steel external housing to protect bellows and support insulation. Furnish limit rods to prevent expansion joint from exceeding rated travel. Joint design shall be for maximum flexibility over 10,000 cycles minimum.

B. Expansion joint sizing and installation shall be as shown on the drawing and as recommended by the manufacturer.

C. Expansion joints shall be insulated with flexible 2" minimum thickness of high temperature fiberglass blanket insulation furnished with joint and installed under the external protective housing.

D. Contractor shall carefully check expansion joint limit rods and make adjustments as required to ensure proper joint movement and operation.

2.22 EXPANSION COMPENSATORS

A. Furnish and install expansion compensators, Hyspan series 8500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, stainless steel laminated bellows with stainless steel or carbon steel shroud, 175 PSIG pressure rating at 250oF, 2 inch straight line expansion and 1/2 inch contraction. Furnish copper tube with sweat ends for compensators installed in copper piping systems. Furnish standard wall carbon steel pipe tube for compensators installed in steel piping systems, threaded connectors for sizes 2" and smaller and Class 150 ASA flange connection for sizes 2-1/2" or larger.

B. Expansion compensators sizing and installation shall be as shown on the drawings and as recommended by the manufacturer.

2.23 PIPE ALIGNMENT GUIDES

A. Furnish and install factory fabricated steel pipe alignment guides, Hyspan Series 9500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, to maintain the longitudinal position of pipe centerline between expansion joints and compensators with axial restraint. Alignment guides shall consist of a bolted two-section outer cylinder and base with two-section guiding spider bolted tight to the pipe guide. Guide and spider shall be sized to clear pipe and pipe insulation and long enough to prevent over travel of spider and cylinder. Guides shall not be used for pipe support.

B. Alignment guides shall be arranged and installed as shown on the drawings and as recommended by the manufacturer.

2.24 PIPE ANCHORS

A. Pipe anchors shall be constructed of welded steel as detailed on the drawings.

B. Pipe anchors shall be arranged as shown on the drawings and as required to properly control/piping system expansion and contraction in conjunction with system flexibility due to off-sets, bends, and loops and expansion joints and compensators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All specialties shall be installed in accordance with the best standard practices and as recommended by the manufacturer.

B. Install thermometers so they are easily readable from operator level.

C. Where thermometers, gauges, vents and test fittings occur in insulated piping systems or on insulated equipment, extension necks shall be provided to extend beyond the insulation.

3.2 AIR VENTS

A. Manual air vents shall be installed as specified herein and at the high points in all piping systems.

B. Automatic air vents shall be installed as specified herein and at locations indicated on the drawings. Automatic air vents shall be installed level and in accordance with manufacturer's directions to properly vent system, complete with individual isolation valves.

3.3 STRAINERS

A. All strainer screens, including basket strainers and suction diffusers, shall be removed and cleaned prior to commencing testing and balancing work and shall be maintained clean through project final acceptance by the Owner. Suction diffuser start-up strainers shall be removed prior to final system testing and balancing work.

3.4 TEST AND ADJUSTMENT

A. Field adjust all water pressure regulating valves, flow switches, water level controls, steam pressure reducing valves and specialties to provide required system operation.

B. Field test and verify the operation of all safety devices including water and steam relief valves and temperature and pressure relief valves.

3.5 RELIEF VALVE DISCHARGE

A. Water pressure relief valve and water temperature and pressure relief valve discharges shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink, and as allowed by the Building Mechanical and Plumbing Codes. When the operating discharge temperature is in excess of 212oF, the discharge shall be equipped with a splash shield or centrifugal separator.

B. Water reduced pressure backflow preventer discharge shall be piped full size to the outside of the building or discharged indirectly into a properly sized building floor drain or floor sink as allowed by the Building Mechanical and Plumbing Codes. Provide a bronze air gap funnel with stainless

steel fasteners for installation under reduced pressure backflow prevention relief valve. Febco Model AGD or equivalent, 1" discharge pipe size for backflow preventer size through 2".

END OF SECTION 26 0505

SECTION 23 0523 – VALVES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS- SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

D. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.

E. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0523 for Valve Identification.

C. Section 23 0504 for Pipe and Pipe Fittings.

D. Section 23 2313 for Refrigerant Piping System.

E. Division 25 for Automatic Temperature Control Valves.

F. Division 21 for fire suppression system valves and tamper switches.

G. Division 22 for plumbing system.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Tyco-Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Tyco-Grinnell, Victaulic, Nibco, or Dezurik, or equivalent. Butterfly valves may be used for closed circuit chilled water, heating hot water (200oF maximum) run-around coil and heat pump circulating water systems and for condensing water systems. Butterfly valves shall not be used for domestic water or other non-specified service.

D. Ball valves shall be utilized in lieu of gate valves and globe valves for all HVAC and plumbing systems for sizes 2" and smaller.

E. Butterfly valves may be substituted for gate, globe and ball valves for specified services, and for other services as may be approved by the Architect.

F. All valves furnished under Division 22 and 23, of the same type, shall be products of a single manufacturer unless otherwise approved by Owner's Representative.

G. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

H. Provide chain operators for valves 4" and larger installed within mechanical equipment spaces where valves center line is in excess of eight feet above the floor or operating platform and as otherwise indicated on the drawings.

PART 2 - PRODUCTS

2.1 GENERAL SERVICE VALVES, HVAC AND PLUMBING SYSTEMS

A. Gate Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, solid disc, rising stem, gland packed, non-asbestos packing. Milwaukee 148 (Threaded) or equivalent; Milwaukee 149 (Solder), or equivalent.

B. Gate Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1151 (Threaded) or equivalent; Milwaukee 1169 (Solder), or equivalent

C. Gate Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1184 (Threaded) or equivalent.

D. Gate Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126

E. Class B cast iron, flanged ends, Class 125 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2885 or equivalent.

F. Gate Valves - 2-1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 250 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2894 or equivalent.

G. Globe Valves - 2" and Smaller, Class 125: Valves 2-1/2" and smaller shall be of ASTM B-62, Class 125 construction, bronze trim, gland packed, non-asbestos packing. Milwaukee 502 (Threaded), or equivalent; Milwaukee 1502 (Solder) or equivalent.

H. Globe Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be of ASTM B-62, bronze, Class 150 construction, bronze trim, composition disc, union bonnet, gland packed, non-asbestos packing. Milwaukee 590 (Threaded) or equivalent; Milwaukee 1590 (Solder), or equivalent.

I. Globe Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be of ASTM B-62, bronze, Class 300 construction, bronze trim, union bonnet, gland packed, non-asbestos packing. Milwaukee 572 (Threaded) or equivalent

J. Globe Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and Larger shall be of ASTM A- 126, Class B cast iron, flanged ends, Class 125 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2981M or equivalent.

K. Globe Valves - 2-1/2" and Larger, Class 300: Valves 2-1/2" and larger shall be of ASTM A- 126, Class B cast iron, flanged ends, Class 300 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2983 or equivalent.

L. Check Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, Y-pattern, swing type design, teflon seat, disc for steam service, Buna-N for water service. Milwaukee 509 (Threaded) or equivalent; Milwaukee 1509 (Solder) or equivalent.

M. Check Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, Y-pattern, swing type design, bronze seat, composition disc, teflon seat disc for steam service, Buna-N for water service. Milwaukee 510 (Threaded) or equivalent; Milwaukee 1510 (Solder) or equivalent.

N. Check Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, Y-pattern, swing type design, bronze regrinding disc. Milwaukee 507 (Threaded) or equivalent.

O. Check Valves - 2 1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A- 126 Class B, cast iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2974M or equivalent.

P. Check Valves - 2 1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A- 126 Class B, cast iron, flanged ends, Class 250 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2970 or equivalent.

2.2 STEAM SERVICE - ABOVE 80 PSIG TO 125 PSIG, MAXIMUM STEAM PRESSURE

A. Gate Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1151 (Threaded) or equivalent.

B. Gate Valves - 2 1/2" and Larger, Class 125:

1. Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 125 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing.
2. Provide factory installed glove valve bypass 1/2" size through 4" valve size, 3/4" size for 6" and 8" valve sizes and 1" for valve sizes 10" and larger, conforming to MSS specification SP.45.
3. Provide drilled and tapped hoses for drains conforming to SP-45 where shown on drawings and as required for proper installation.
4. Milwaukee F2885 or equivalent.

C. Globe Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, bronze trim, composition disc, union bonnet, gland packed, non-asbestos packing. Milwaukee 590 (Threaded) or equivalent.

D. Globe Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A- 126, Class B Cast Iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, gland packed, non-asbestos packing. Milwaukee F2981 or equivalent.

E. Check Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, Y-pattern, swing type design, bronze seats, composition disc, teflon seat disc for steam service, Buna-N for water service. Milwaukee 510 (Threaded) or equivalent.

F. Check Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be cast of ASTM B-62 bronze, Class B, cast iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2974M (Threaded) or equivalent.

2.3 STEAM SERVICE - ABOVE 125 PSIG TO 150 PSIG, MAXIMUM STEAM PRESSURE

A. Gate Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be bronze Class 150 construction, threaded connections. Milwaukee 1151 or equivalent as specified herein or equivalent.

B. Gate Valves - 2 1/2" and Larger, Class 250:

1. Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 250 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing.
2. Provide factory installed glove valve bypass 1/2" size through 4" valve size, 3/4" size for 6" and 8" valve sizes and 1" for valve sizes 10" and larger, conforming to MSS specification SP-45.
3. Provide drilled and tapped hoses for drains conforming to SP-45 where shown on drawings and as required for proper installation.
4. Milwaukee F2894 or equivalent.

2.4 STEAM CONDENSATE VALVES

A. Gate Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be bronze, Class 150 construction. Milwaukee 1151 (threaded), Milwaukee 1169 (solder), as specified herein or equivalent.

B. Gate Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be cast iron, Class 125 construction, OS & Y pattern. Milwaukee F-2885, as specified herein or equivalent.

C. Check Valves - 2 1/2" and Smaller, Class 150: Valves 2-1/2" and smaller shall be bronze, Class 150 construction, threaded connections, Milwaukee 510, as specified herein or equivalent.

D. Check Valves - 2 1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be cast iron, Class 125 construction, flanged connections. Milwaukee F2974M, as specified herein or equivalent.

2.5 BUTTERFLY VALVES

A. Valves 2-1/2" and larger shall be full lug pattern, ASTM A-126, Class B cast iron body, 416-SS stems, aluminum/bronze disc, EPDM liner and seats (-30oF to 275oF) w/rigid phenolic cartridge, 200 PSIG working pressure with Bubble tight shut-off. Valves shall be for mounting between flanges with lugs drilled and tapped so that pipe may be disconnected on either side of valve with opposite end remaining under pressure. Milwaukee ML-123-E or equivalent.

B. Valves 4" and smaller shall be provided with level handler operator with spring loaded lock stops. Valves 5" and larger shall be furnished with manual gear operator with hand wheel.

C. Valves installed for insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing.

D. Butterfly valves furnished for use in grooved piping system shall meet the material specification requirements as specified herein.

2.6 BALL VALVES

A. Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, 600 PSI

B. W.O.G. Two-piece body, chrome plated ball, blowout proof stem, reinforced TFE seats, non-asbestos packing. Milwaukee BA-100 (threaded) or equivalent. Milwaukee BA-150 (solder) or equivalent.

C. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing. Cutting or notching of the insulation or bending of handles shall not be permitted.

2.7 BALANCE VALVES

A. Valves 2" and smaller: Ball valve, bronze, Class 150 construction, 600 PSI W.O.G., Two piece body, Milwaukee BA-100 (threaded). Milwaukee BA-150 (soldered), as specified herein or equivalent.

B. Valves 2-1/2" and larger: Lubricated plug valve, cast iron construction, 175 PSI W.O.G., Class 125 flange connections, level handle for valves 4" and smaller, manual gear operator with handle wheel for valve 5" and larger. Walworth No. 1797F or equivalent.

C. Valves 2-1/2" and larger:

1. Butterfly valve, full lug pattern, as specified herein.
2. Furnish level handle with infinite throttling positions and locking device for securing handle in any position for valves 4" and smaller and manual gear operator with hand wheel for valves 5" and larger.

D. Flow control and Flow Balance Valves: For calibrated flow balance valves and automatic flow control valves, see Specification Section 23 0505, Piping Specialties.

2.8 NATURAL GAS VALVES

A. Valves 3/4" and Smaller: Bronze natural gas cock, Walworth No. 590 (square head), Walworth 591 (flat head) or equivalent.

B. Valves 3" and Smaller: Ball valve shall be cast of ASTM B-584 bronze, Class 250 construction, threaded connections, chrome plated big ball and stem, RDTFE seat and stem packing, blow-out proof stem, UL Listed for natural gas service, Apollo 80-100 Series or equivalent.

C. Valves 4" and Larger: Lubricated plug valve, cast iron construction, 175 PSIG W.O.G., threaded connection for valves 2" and smaller, Class 125 Flange connections, level handle operator. Walworth No. 1797F (Flanged) or equivalent.

2.9 MANUAL AIR VENTS AND DRAIN VALVES

A. For manual air vents and drain valves, see Specification Section 23 0505, Piping Specialties.

2.10 NON-SLAM SILENT CHECK VALVE

A. Check valves for pump discharge and other required non-slam silent operation, shall be center guided, suitable for vertical or horizontal installation position, cast iron in semi-steel body, bronze disc and trim, stainless steel spring, Buna-N seats, Class 125 or 250 construction, as required by the application, wafer or globe flanged pattern for valves 2" through 10" size and flanged pattern for valves 12" and larger. Milwaukee 1400 Series (wafer) or equivalent. Milwaukee 1800 Series (globe) or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.

B. Gate and Globe valves shall be installed with stems horizontal.

END OF SECTION 23 0523

SECTION 23 0548 – MECHANICAL VIBRATION CONTROL AND ISOLATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for vibration control systems to be used in all phases of architectural, mechanical, process, electrical, and structural work.

B. This Specification provides the necessary design for the avoidance of excessive vibration in the building due to the operation of machinery or equipment and/or due to interconnected piping, ductwork, conduit, or structures.

C. Due to the nature of this facility the design criteria may exceed those of normal industrial construction. It is imperative that close attention be paid to all specifications and details for noise and vibration control.

1.2 RELATED WORK

A. In the event of conflict regarding mechanical vibration control requirements between this Section and any other Section, the provisions of this Section shall govern.

1.3 CONTRACTOR'S GENERAL RESPONSIBILITIES

A. The Contractor shall bring to the Architect's attention prior to installation any conflicts which will result in unavoidable contact between the building structure and the isolated equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the expense of the responsible contractor.

B. The Contractor shall bring to the Architect's attention prior to installation any discrepancies between the requirements of this Specification and field conditions, changes required due to specific equipment selection, etc. Corrective work necessitated by discrepancies after installation shall be at the expense of the responsible contractor.

1.4 DESIGN CRITERIA

A. Equipment, ductwork, piping and conduit shall not be installed which makes rigid contact with the structure unless it is allowed by this specification.

B. Pipe Anchors and Supports: Piping supports and anchors shall not interfere with free operation of vibration isolation systems. Stiff-leg support of piping supported on Type HS, or Type FSN isolators is not acceptable.

C. Ductwork: Ductwork isolation requirements are based on duct equivalent diameters. For rectangular ductwork, the equivalent diameter is the diameter of duct having the same cross-sectional area.

D. Equipment Isolation Frames and Bases: Frames and bases used to support vibration isolated pumps shall be sized to provide support for pipe elbows.

E. Isolation/Absorption Products: The completed installation must be free of vibration and noise. Systems, equipment, or parts which vibrate or generate vibration unduly, or which generate or emit undue noise while in operation, shall: (1) be adjusted, repaired, or replaced as appropriate to obtain acceptable levels of vibration or noise, or (2) be supported on, or fitted with, suppression or absorption devices, or other means, which effectively prevent the transmission of vibration or noise beyond the offending item.

F. Resilient Wall, Ceiling, and Floor Penetrations: Provide resilient wall and ceiling penetrations for all piping, conduit, ductwork, etc. supported on Type HS or Type FSN isolators. Refer to resilient penetration details on the Drawings.

1.5 COORDINATION

A. The Work under this Section must be coordinated with all other mechanical, electrical and structural work in order to accomplish the interfacing necessary to provide a complete and operating system in conformance with the intent of the Subcontract Documents.

1.6 SUBMITTALS

A. Provide the following in addition to the standard requirements:

1. A general statement of materials and methods intended for use on this project within 45 days of subcontract execution or notice to proceed, whichever is later. Specific information shall be provided for all items described under the products section of this Specification. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature, which shall include make, model, dimensions, weight and interface description with other work, shall be supplied. Complete performance data are required that shall indicate full compliance with specifications as outlined.
2. Complete detailed shop drawings showing the intended locations and construction features of all types of products specified. Shop drawings shall be submitted in a timely manner.
3. Catalog cuts and data sheets on specific vibration isolators shall be provided showing compliance with the specification.
4. An itemized list showing items to be isolated, the isolator type, model number, isolator loading and deflection, and reference to specific drawing showing frame construction where applicable.
5. Detailed selection data for each vibration isolator supporting equipment, including:

    a. The equipment identification mark.
    b. The isolator type.
    c. The actual load. The static deflection expected under the actual load.
    d. The specified minimum static deflection.
    e. The additional deflection to solid under load.
    f. The ratio of spring height under actual load to spring diameter.

6. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, and support point locations.

7. Written approval of the frame design to be used shall be obtained from the equipment manufacturer.
8. Drawings showing methods for suspension, of support, and guides.
9. Drawings showing methods for isolation of piping, at penetrations of walls, slabs, and beams.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The intent of this specification is to ensure the highest standard of vibration isolation for this project. For this reason, all vibration isolation products and materials shall be furnished by a single manufacturer, who will be responsible for the proper installation and operation of all vibration isolation equipment and systems. The only exception will be internal vibration isolation that is integral with the equipment, such as internal isolators on air handling units.

B. All vibration-isolation mounts shall be supplied by one of the following approved manufacturers:

1. Mason Industries Inc. (M.I.), Hauppauge, New York.
2. Kinetics Noise Control Inc. (K.N.C.), Dublin, Ohio.
3. Vibration Mountings & Controls, Inc. (V.M.C.), Bloomingdale, NJ.

2.2 VIBRATION ISOLATORS

A. General:

1. Metal parts of vibration-isolation units shall be as follows: Galvanizing shall meet ASTM Salt Spray test Standards and Federal Test Standard no. 14.

    a. Housing: Hot-dipped galvanized or fusion epoxy coated.
    b. Hardware (washers, nuts, bolts, etc.): Cadmium plated.
    c. Springs shall be neoprene coated.

2. All isolators installed outdoors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Subcontractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevation during installation and initial system filling operations, and similar installation advantages. Accessories shall not degrade the vibration isolation system.
4. Static deflection of isolators shall be as indicated in Table 230550, Vibration Isolation Schedule. All static deflections stated are the minimum acceptable deflection for the mounts under actual load.
5. The use of nested springs or of multiple parallel springs within a single mount is not permitted.

B. Unit FSN (Floor Spring and Neoprene):

1. Spring isolators shall be free-standing and laterally stable without any housing. Spring diameter shall be not less than 0.8 times the compressed height of the spring at the design load. Springs shall have a minimum additional travel to solid equal to 50 percent of the actual deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1. All mounts shall have leveling bolts.
2. The spring element in the isolator shall either be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a unit DNP isolator. If the DNP isolator is used, a rectangular bearing plate of appropriate size to load the pad uniformly in the range of 40 to 50 psi shall be provided. If the spring isolator is supplied with a neoprene friction pad, a stainless steel, aluminum, or galvanized steel plate shall be used between the friction pad and the DNP isolator. The DNP isolator, separator plate, and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
3. If the isolator is to be fastened to the building structure and a unit DNP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down bolt assembly shall include washers to distribute load evenly to the grommet. Bolts and washers shall be galvanized.
4. Unit FSN isolators shall be one of the following products, or approved equal, with the appropriate neoprene pad (if used) selected from Unit DNP:

    a. Type SLF: M.I.
    b. Type FDS: K.N.C.
    c. Type AC or AD: V.M.C.

C. Unit FSNTL (Floor Spring and Neoprene Travel Limited):

1. Spring isolators shall be free-standing and laterally stable without any housing. Spring diameter shall be not less than 0.8 times the compressed height of the spring at the design load. Spring shall have a minimum additional travel to solid equal to 50 percent of the actual deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1. All mounts shall have leveling bolts. All mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of 1/4 inch shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.
2. The spring element in the isolator shall either be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a unit DNP isolator. If the DNP isolator is used, a rectangular bearing plate of appropriate size to load the pad uniformly in the range of 40 to 50 psi shall be provided. If the spring isolator is supplied with a neoprene friction pad, a stainless steel, aluminum, or galvanized steel plate shall be used between the friction pad and the DNP isolator. The DNP isolator, separator plate, and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
3. If the isolator is to be fastened to the building structure and a unit DNP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down bolt assembly shall include washers to distribute load evenly to the grommet. Bolts and washers shall be galvanized.

4. Unit FSNTL isolators shall be one of the following products, or approved equal, with the appropriate neoprene pad (if used) selected from Unit DNP

    a. Type SLR: M.I.
    b. Type FLS: K.N.C.
    c. Type AWR-1: V.M.C.

D. Unit FN (Floor Neoprene):

1. Neoprene isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener.
2. The mounts shall include leveling bolts that may be rigidly connected to the equipment.
3. Unit FN isolators shall be one of the following products or approved equal:

    a. Type ND: M.I.
    b. Type RD: K.N.C.
    c. Type R/RD: V.M.C.

E. Unit NP (Neoprene Pad)

1. Neoprene pad isolators shall be one layer of 1/4-inch to 5/16-inch thick ribbed or waffled neoprene. Neoprene shall be 40 to 50 durometer. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Unit NP isolators shall be one of the following products or approved equal:

    a. Type W: M.I.
    b. Type NPS: K.N.C.
    c. Type Shear-Flex or Maxi-Flex: V.M.C.

F. Unit DNP (Double Neoprene Pad):

1. Neoprene pad isolators shall be formed by two layers of 1/4-inch to 5/16-inch thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. these layers shall be permanently adhered together. Neoprene shall be 40 to 50 durometer. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Unit DNP isolators shall be formed from one of the following products or approved equal:

    a. Type WSW: M.I.
    b. Type NPS: K.N.C.
    c. Multiple Layers of Type Shear-Flex or Maxi-Flex: V.M.C.

G. Unit HS (Hanger Spring):

1. Vibration-isolation hangers shall consist of a free-standing laterally stable steel spring set into a neoprene cup, contained within a steel housing. The neoprene cup shall be manufactured with a grommet (or other element) to prevent the hanger rod from contacting the hanger housing. A steel washer shall be provided in the neoprene cup to evenly distribute load onto the neoprene.
2. The plate or washer at the top of the spring shall be welded to the spring. The hanger rod shall be securely fastened to this plate or washer using lock nuts. The hanger rod shall have

a diameter not less than 5/8 inch. This design represents a modification to the unit types given below. The modification is intended to limit the side-to-side motion of the hanger rod relative to the hanger casing.

3. Spring diameter and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the housing. Spring elements shall have minimum additional travel to solid equal to 50 percent of the actual deflection.
4. Upper hanger rod attachment shall be made through a neoprene rubber-in-shear element designed to avoid direct contact between the hanger rod and the isolator frame.
5. Springs shall be color coded for ease of identification and removable, for field connection.
6. Unit HS isolators shall be one of the following products or approved equal:

    a. Type 30N (modified): M.I.
    b. Type SH (modified): K.N.C.
    c. Type RSH (modified): V.M.C.

2.3 EQUIPMENT BASES

A. Unit BSF (Base Steel Frame):

1. Steel base frames shall consist of structural steel sections sized, spaced, and connected to form a rigid base which will not twist, deform, or deflect in any manner which will negatively affect the operation of the supported equipment of the vibration-isolation mounts. Frames shall be adequately sized to support basic equipment units and mounts plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. The depth of steel frame bases shall be at least 1/10 the longest dimension of the base with a minimum depth of 6 inches, but not more than 12 inches. Frame bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
2. Unit BSF base shall be supplied by the isolator manufacturer and shall be one of the following products or approved equal:

    a. Type WFSL: M.I.
    b. Type SFB or SRB: K.N.C.
    c. Type WFB: V.M.C.

B. Unit BIB (Base Inertia Base):

1. Concrete inertia bases shall be formed of stone-aggregate concrete (150 pounds per cubic ft.) and appropriate steel reinforcing cast between perimeter structural steel channels. Inertia bases shall be built to form a rigid base which will not twist, deform, or deflect, in any manner which would negatively affect the operation of the supported equipment or the vibration isolation mounts. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 1/12 the longest dimension of the inertia base but not less than 6 inches and not more than 12 inches. The weight of the inertia base, as a minimum, shall be 1 to 2 times that of the total weight of the equipment (including the attached piping it is

supporting and other applicable loads). In special applications such as reciprocating compressors, the inertia base weight requirement could be higher and shall be calculated on a case-by-case basis. Inertia bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.

2. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Concrete shall be provided by the appropriate Subcontractor.
3. Inertia bases used to support vibration-isolated pumps shall be sized to provide support for pipe elbows and suction diffuser. Inertia bases used to support vaneaxial fans shall be long enough to support fan diffusion cones.
4. Frame and reinforcement for Unit BIB bases shall be one of the following products or approved equal:

    a. Type KSL: M.I.
    b. Type CIB-L or CIB-H: K.N.C.
    c. Type WPF: V.M.C.

2.4 SNUBBERS

A. Snubbers to limit the vertical and horizontal motion of the isolated equipment under seismic load shall be fabricated from steel. A neoprene pad, 1/4-inch minimum thickness, shall be affixed at the point of contact. There shall be no contact between snubbers and the inertia base or equipment support frame during normal operation. Minimum of one snubber per side, four total, shall be required on each base. Seismic snubbers shall meet seismic requirements defined in other standard specification sections.

B. Snubbers shall not be finally installed* until vibration isolators are in place and adjusted with actual operating loads.

* It is advisable to install temporary snubbers during construction to guard against seismic events.

C. Snubbers should be equal to Model HS-4 manufactured by Kinetics Noise Control (K.N.C.), Model Z-1225 manufactured by Mason Industries (M.I.), or field-fabricated to a similar design.

2.5 FLEXIBLE CONNECTORS

A. Flexible Duct Connections: Flexible duct connections shall be supplied in accordance with industry standards. Material width shall be 150 percent of clear dimension in addition to width required for attachment. Flexible duct connections shall result in a loose and highly compliant connection. Provide 3-inch minimum clearance between equipment casing and ductwork.

B. Flexible Pipe Connections: Flexible pipe connectors shall be fabricated of Kevlar or nylon cord, fabric, and neoprene. Flexible pipe connections shall result in a flexible and highly compliant connection that can allow longitudinal, transverse, and angular movements and provide micro-vibration isolation. The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure, and fluid type. Rods or cables may be used to control extension of the connector if required by the manufacturer, but shall not inhibit movement necessary to provide sufficient vibration isolation. Flexible pipe connections shall be one of the following products or approved equal:

a. Type SFDEJ: M.I.
b. Double Sphere (Type DS): Metraflex
c. Type VMT: V.M.C.

C. Flexible Conduit Connections: Flexible conduit shall be formed of one continuous length of electro-galvanized spiral-wound steel strip. Liquid-tight flexible conduit shall be formed of one continuous length of electro-galvanized spiral-wound steel strip, with neoprene gasket.

2.6 THRUST RESTRAINTS

A. Thrust restraints shall consist of pre-compressed steel spring, neoprene cup, threaded rod, and angle brackets designed to resist the effects of fan thrust and prevent the collapse or over extension of flexible duct couplings and attendant short circuiting of the fan vibration isolation system.

B. Minimum operating deflection of steel spring shall not be less than 1/2 the deflection of the equipment support isolator.

C. Mason Industries, Inc.: Model WBI and Model WBD.

2.7 RESILIENT PENETRATION SLEEVE/SEAL

A. Provide resilient wall and ceiling penetrations for all piping, conduit, ductwork, etc., supported on vibration isolators. Refer to resilient penetration details on Drawings.

2.8 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient penetration sleeve/seals shall be field fabricated from a pipe or sheet metal section that is at least 1 inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated. The sleeve shall extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element shall be packed tightly with glass fiber or mineral wool to within 1/4 inch of the end of the sleeve. The remaining 1/4 inch space on each side shall be filled with acoustical sealant to form an airtight seal. The penetrating element shall be able to pass through the sleeve without contacting the sleeve. Alternatively, prefabricated sleeves accomplishing the same result are acceptable. Coordinate with penetration details shown on the Drawings.

C. Resilient lateral guides shall be one of the following products or approved equal:

a. Type ADA: M. I.
b. Type MDPA: V. M. C.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall obtain inspection from the Architect of any installation to be covered or enclosed prior to such closure.

B. The Contractor shall obtain written and/or oral instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices.

C. The Contractor shall correct, at no additional cost, all installations which are deemed defective in workmanship or materials by the Architect.

D. The Contractor shall be responsible for proper operation of all systems, minor sub-systems, and services provided under this Section. The Contractor shall coordinate startup procedures, calibration, and system check-out with all contractors involved. Any system operational problems shall be diagnosed. All correctional procedures shall be initiated by the various contractors as required to bring the system into compliance with the design, and the problem shall then be rechecked to verify that the system operates normally. Any remaining difficulties shall be brought to the attention of the Architect.

3.2 ISOLATOR INSTALLATION

A. The installation or use of vibration isolators must not cause any change of position of equipment, conduit, piping or ducting, which would result in stresses in connections or misalignment of shafts or bearings. In order to meet this objective, equipment and attached systems shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load. All plumbing, piping, and ducting at mechanical equipment connections is to be fully supported by specified hangers. Mechanical equipment and vibration mounts shall not carry plumbing, piping, or ducting loads.

B. Equipment Isolator Installation:

1. Space saver brackets shall be used for equipment supported on Type FSN vibration isolators.
2. The minimum operating clearance between the underside of the frame or inertia base and the pad or floor shall be 1 inch.
3. The frame shall be placed in position and supported temporarily by shims prior to the installation of the machine or isolators.
4. After the entire system installation is completed and under full operational load, the isolators shall be adjusted so that the load is transferred from the shims to the isolators. When all isolators are properly adjusted, the shims will be barely free and shall be removed.
5. Seismic snubbers shall not be finally installed until vibration isolators are in-place and adjusted with actual operating loads.

C. Isolator Hangers

1. The isolators shall be installed with the isolator hanger box as close as possible to the structure.

2. The isolators shall be suspended from massive beams, never from slab diaphragms between beams.
3. Orientation of isolator assembly including support and load rods shall be within five degrees of vertical.

D. Thrust Restraints

1. Thrust restraints shall be provided in accordance with manufacturers recommendations for all horizontal discharge vibration isolated fans and air handlers where the air thrust exceeds 10 percent of the vibration isolated equipment weight.
2. Thrust is calculated in accordance with the following formula:

E. THRUST (LB) = TOTAL PRESSURE (INCHES W.C.) x 5.3 x AREA (SQ. FT.)

1. Thrust restraints shall be oriented parallel to the direction of thrust and located symmetrically about the center of thrust. Ducting at thrust restraints shall be designed to withstand thrust loading or an auxiliary structure shall be provided for thrust restraint mounting.
2. Thrust restraint shall not interfere with or restrict free operation of vibration isolation systems.

3.3 PIPING ISOLATION

A. Pipe support isolation shall comply with the following general guidelines:

1. Spring isolators shall be selected for a static deflection, under load, of not less than 1 inch. Unit FSN or HS isolators (whichever is applicable to the mounting condition) shall be used.
2. Where lateral support of pipe risers is required within the limits of isolation specified below, this shall be accomplished by use of resilient lateral supports.
3. Pipes that penetrate the building structure within the limits of isolation specified below shall be isolated from the structure by use of resilient penetration sleeve/seals.
4. Drain piping connected to vibration-isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently mounted as described above.
5. Piping connected to vibration-isolated equipment shall be installed so that it does not strain or force out of alignment pipe flexes or vibration isolators supporting either the equipment or the piping.
6. Where pipes are racked together, the most stringent isolation requirement, as defined in this specification shall take precedence.
7. Piping, 2" diameter or greater, which is connected to vibration isolated equipment shall be isolated from the building structure using spring supports, resilient pipe guides, and resilient penetration sleeves (as applicable) for a distance of 25 feet or 50 pipe diameters, whichever is greater.

3.4 ELECTRICAL ISOLATION

A. Electrical service connections to all vibration isolated mechanical equipment shall be made with flexible conduit. Conduit shall provide a minimum 90 degree turn and result in a loose and compliant connection.

B. Transformers rated at or above 200 kVA shall be supported on Type DNP vibration isolation pads or provided with integral internal neoprene vibration mounts. For dry transformers, install the isolation beneath the core; for oil-filled transformers, install the isolation beneath the tank.

3.5 EQUIPMENT BALANCE REQUIREMENTS

A. All rotating equipment shall operate at speeds less than 80 percent of their true critical speed. Unless otherwise required, equipment shall be balanced according to the recommendations given in the following sections.

B. Equipment components such as motors, pump rotors, fan wheels, etc. shall be factory balanced, both statically and dynamically, to meet the field balance requirements described in Paragraph

C. 3.7.C below.

D. Pumps, compressors, fans not covered below, and other rotating equipment shall be field tested in accordance with ANSI Standard S2.41 (current edition) by an independent company after installation and under actual operating conditions. Vertical and horizontal vibration of rotating equipment shall not be greater than 0.071 in/sec RMS (0.1 in/sec 0-peak) velocity. The vibration shall be measured on the equipment bearing caps when the equipment is mounted on its vibration isolation mounts. If the equipment is mounted on an inertia base, or is skid- mounted, see Paragraph 3.7.D below for installed balance requirements. A balance report will be provided for each item of equipment.

E. Inertia Base or Skid-Mounted Equipment Balance: The weight of inertia bases or skids (and of any other components mounted on the same inertia base or skid) will reduce the vibration response when equipment is balanced. Therefore, the balance criteria, as specified in Paragraphs 3.7.C and 3.7.D, shall be multiplied by the following factor for such equipment:

$$\text{Factor} = \frac{W}{WT+W}.$$

Where

WT = Inertia weight (base + other components)
W = Weight of the subject equipment

END OF SECTION 22 0548

SECTION 23 0549 – HAVC AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Division 1, LEED Commissioning.

B. Section 23 0500, Common Work Requirements for HVAC.

C. Division 25, Facility Management System.

D. Division 26 for Electrical.

E. Division 28 for Electronic Safety and Security.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 23 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 23	Div. 23	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div. 25
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 25
Variable Frequency Drives (VFD's)		Div. 23	Div. 23	Div. 26	Div. 25
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 23	Div. 23	Div. 26	Div. 25
Central Plant/Refrigeration Equipment Room Emergency Shutdown & Ventilation		Div. 23	Div. 23	Div. 26	Div. 23
Refrigeration Gas Monitor		Div. 23	Div. 23	Div. 26	Div. 25
Fan Coil Units Including Return Air Dampers		Div. 23	Div. 23	Div. 26	Div. 25
Water Chillers		Div. 23	Div. 23	Div. 26	N/A
Min. Outside Air Units Including Mixing Dampers		Div. 23	Div. 23	Div. 26	Div. 25
Rooftop A/C Units Including Mixing Dampers		Div. 23	Div. 23	Div. 26	Div.25
HVAC Unit Smoke Detectors		Div. 28	Div. 23	Div. 28	Div. 28
Fire/Smoke Control Dampers & Smoke Dampers		Div. 23	Div. 23	Div. 26	Div. 28
Fan Coil Unit Condensate Float Switches		Div. 23	Div. 23	N/A	Div. 25
Supply, Return & Exhaust Fan with unit mounted 115 VAC 2-position damper actuators interlock with fan motor/starter		Div. 23	Div. 23	Div. 26	N/A
Non-FMS Control Devices Including Wall Switches, Timers, Thermostats		Div. 23	Div. 23	Div. 26	Div. 26
Chemical Treatment Systems		Div. 23	Div. 23	Div. 26	N/A
Facility Management System (FMS)	(2)	Div. 25	Div. 25	Div. 25	Div. 25
Facility Management System - Light Controls		Div. 26	Div. 26	Div. 26	Div. 26
Fire Alarm System & Interface w/HVAC System		Div. 28	Div. 28	Div. 28	N/A

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall provide 120 VAC power to each mechanical space and the central plant as indicated on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 23 indicates the HVAC contractor or their designated representative including equipment suppliers, sub-contractors, etc. Division 25 indicates the Integrated Automation Contractor.

END OF SECTION 23 0549

SECTION 23 0550 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, the Supplemental General Conditions, and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 3000, HVAC Air Distribution Systems and Equipment.

C. Section 23 0593, Testing, Adjusting and Balancing.

D. Division 25, Facility Management System.

E. Division 22, Section 22 0550, for plumbing variable frequency drives.

1.3 GENERAL

A. Variable frequency drives shall be coordinated with the equipment being furnished and the wiring coordinated with the Division 26 contractor.

B. Do not connect power factor correction devices in the electrical circuit serving any variable frequency drive or the motor downstream of the drive.

C. All associated equipment motors shall be inverter duty in compliance with standard NEMA MG 1 Part 31 to ensure the compatibility between the VFD and motor.

D. Manufacturer's Qualifications: Firms regularly engaged in manufacture of variable speed ac motor drives of types and ratings required, whose products have been in satisfactory use in similar service for not less than five years. All Division 23, HVAC and Division 22, Plumbing variable frequency drives shall be of one manufacturer/model series and be provided by the exclusive local representative for sole source responsibility of all aspects of sales, startup, service, training and warranty.

E. Variable frequency drives shall be manufactured by Asea Brown Boveri (ABB), Series ACH 550, or equivalent.

1.4 SUBMITTALS

A. Refer to Sections 23 0500 for additional requirements.

B. Product Data: Submit manufacturer's data including catalog information, performance data efficiency, harmonic distortion, RFI/EMI (Radio Frequency Interference/Electromagnetic Interference) specifications, installation instructions and general recommendations for each type or size of motor.

C. The VFD manufacturer shall provide calculations as part of the shop drawing submittal specific to this installation showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by manufacturer to ensure compliance with IEEE Standard 519-1992, "Guide for Harmonic Control and Reactive Compensation for Static Power Converters."

D. The manufacturer furnishing the variable frequency drives shall be responsible for noise created by VFD's and/or motors. The manufacturer shall submit his noise test data based on the following: Sound power level at any speed output of the VFD, measure 3 ft. from the motor, shall not exceed 1.2 times the sound power level of the motor running in bypass mode with 60 Hz incoming line power. Measurements shall be recorded at 10 (minimum) different operating speeds.

E. Shop Drawings: Submit dimensioned drawings of cabinet and front panel layout, showing accurately scaled switches, their layouts and proximity to associated equipment. Furnish control schematic connection diagram showing all field connections.

1.5 SCOPE

A. Furnish and install pulse width modulating (pwm) output wave HVAC Variable Frequency Drives (VFD) and control wiring between the VFD control system as specified in Section 23 0550.

B. The Variable Frequency AC Motor Drive shall be designed to convert the [460 volt] with a tolerated voltage window ± 30%, 3 phase, 60 Hz input power to 0 to [460 volt], 3 phase, 0-60 Hz variable frequency output power. The output frequency and voltage of the drive shall be variable such that a constant volts/Hz ratio is maintained throughout the operating range. The volts/Hz ratio shall be adjustable.

C. The drive shall be capable of operating any standard "off-the-shelf," NEMA B Design, squirrel cage induction motor with a 1.15 SF. The full load amp rating of the drive adjusted as required for jobsite elevation and ambient conditions shall be not less than 5% greater than the FLA rating of the motor or VFD must be oversized.

D. For maintenance purposes, the drive shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).

E. Equipment will be designed and manufactured in accordance with applicable current NEMA, IEEE Standard 519-1992, (IEEE Guide for Harmonic Content and Control), UL 508, ISC 6

F. Enclosures for Industrial Controls and Systems, and IEC 801-2, 801-4, 255-4 recommendations and be designed for installation per NEC. Equipment will have UL, CUL, or ETL Listing or CSA listing as approved and accepted by the state and local code authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Each VFD shall be of the pulse width modulating design and shall consist of:

1. A full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a controlled DC voltage.
2. A DC bus filter with a power factor of .95 or better over the entire speed range.
3. The drive efficiency shall be 97% or better at full speed and full load. Efficiency shall not be less than 80% at 50% speed and load.
4. An inverter section to change the controlled DC voltage to a PWM adjustable voltage/frequency output for complete motor speed control. The inverter output will be generated by power transistors which will be controlled by six identical base driver circuits.

B. The VFD shall include the following:

1. The unit enclosure shall be NEMA Type 1, metal cabinet with front hinged access doors allowing access to all internal electric connections. Any VFD's mounted inside an equipment room with unducted return air and/or mounted in AHU (air handling unit) shall be furnished with NEMA type enclosure required by the local Construction Codes. All VFD's shall be UL Listed as plenum rated.
2. Electronic switching components shall be insulated gate/bipolar transistors, (IGBT).
3. An externally operated, door interlocked, fused disconnect switch or circuit breaker shall be provided. The base VFD shall be UL Listed with a short circuit interrupting rating of 100,000 symmetrical amps minimum without the need for input fuses. The DC Buss output shall be fused separately or electronically protected, with an indicating pilot light.
4. An internal 115V AC control power circuit with transformer and protective fuses shall be included or 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others.
5. Provide solid state relay interface for remote start/stop in both VFD and bypass mode independent of safety circuits.
6. Low frequency/low voltage start with linear adjustable ramp up to pre-selected speed.
7. Controlled acceleration and deceleration, separately adjustable, shall be provided from 2 to 180 seconds with torque limit override acceleration protection, and regeneration protection.
8. Critical Frequency lock out to skip over frequencies that may cause unstable operation in equipment being controlled. Provide at least three separate lockout settings.
9. The VFD 'run permissive circuit' will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a system ready command/contact closure.
10. Furnish line reactors/inductors with minimum 5% impedance designed to provide proper protection of harmonics and transients for the drive input power line. This is a minimum requirement and the manufacturer shall furnish higher rated line reactors or isolation transformers as may be necessary to maintain specified maximum total harmonic voltage distortion. Line reactors/transformers shall be factory mounted and wired within VFD enclosure. The 5% impedance reactors may be from dual (positive and negative DC bus) reactors, or 5% impedance AC line reactors. VFD's with only one 5% DC reactor shall add AC line reactors.

11. EMI / RFI (Radio Frequency Interference/Electromagnetic Interference) filters. All VFD's shall include EMI/RFI filters onboard to allow the VFD assembly to be CE marked and meet product Standard EN 61800-3 for the First Environment restricted level.
12. All components must be accessible from the cabinet door for service. The control shall be microprocessor based and the control card shall be the same part number and fully interchangeable for all ratings and voltages of VFD's.
13. Drive must be designed for against the wall and/or floor mounted arrangements, as required by the project installation requirements.
14. The drive shall be software programmed to provide automatic restart after a power outage or trip from overcurrent, over voltage, under voltage or over temperature. A delay shall occur before restart to allow motor to stop completely. The drive shall shut down and shall require manual restart if the automatic reset/restart function is not successful within 3-5 attempts within a short time period.
15. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start). The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed.
16. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
17. Furnish terminal strip for external interlocks, isolated from the line and ground.
18. Furnish prewired keypad with 3-position HAND-OFF-AUTO switches/buttons and manual speed control that will incorporate "bumpless transfer" of speed reference when switching between "HAND" and "AUTO" modes. When in "HAND," the VFD will be started, and the speed will be controlled from the manual speed control. When in "OFF," the VFD will be stopped. When in "AUTO," the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
19. The drive shall employ three (3) current limit circuits to provide trip-free operation:
    a. The Slow Current Regulation limit circuit shall be adjustable to 125% (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
    b. The Rapid Current Regulation limit shall be adjustable to 170% (minimum) of the VFD's variable torque current rating.
    c. The Current Switch-Off limit shall be fixed at 255% (minimum, instantaneous) of the VFD's variable torque current rating.
20. The overload rating of the drive shall be 110% of its variable torque current rating for one (1) minute every 10 minutes, and 140% of its "H" torque current rating for two (2) seconds every 15 seconds.
21. The VFD shall have door interlocked thermal magnetic circuit breaker which will disconnect all input power from drive and all internally mounted options when bypass is required. The disconnect handle shall be thru-the-door type, and be padlockable in the OFF position.
22. The VFD shall have input line fuses mounted in drive enclosure.
23. The VFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer. VFD shall reduce the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD.

C. The VFD shall have a programmable digital operator's keypad located in the front door of the drive enclosure which shall include the following features and requirements.

1. All VFD's shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (START/STOP, FORWARD/REVERSE, and speed adjust), for setting all parameters, and for stepping through the displays and menus.
2. A VFD mounted transfer switch motor selection option shall be provided to allow the operator to manually transfer between two motors. Interlocking shall be provided to prevent switching of the drive while operating. Use of external motor starters shall not be allowed.
3. The VFD shall give the user the option of either 1) displaying a fault, or 2) running at a programmable preset speed or last speed known if the input reference (4-20 mA or 2- 10V) is lost; as selected by the user.
4. The VFD's shall utilize plain English digital display (code numbers are not acceptable). The digital display shall be a 40-character (2 line x 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle. All set-up parameters, indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
5. There shall be a built-in time clock used to date and time stamp faults and record operating parameters at the time of fault. The clock shall also be programmable to control start/stop functions, constant speeds and four (4) separate, independent timer functions that have both weekday and weekend settings.
6. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The digital keypad shall be removable, capable of remote mounting and uploading/downloading parameters and HVAC specific Application Macros that shall provide one (1) command to reprogram all parameters and customer interfaces for a particular application to reduce programming time and initial start-up of multiple VFD's.
7. The VFD shall have a manual speed control integral to the keypad.
8. Analog meter - output percent of maximum speed.
9. VFD shall have RS-485 port. The standard protocols shall be Modbus RTU, Johnson Controls N2 bus, Siemens Building Technologies FLN and BACnet available. No additional hardware, firmware, gateways, etc., shall be required for these standard protocols. Optional protocols for Lon Works, Profibus, Ethernet, and DeviceNet shall be available, and have the protocol in each VFD. The use of third party gateways and multiplexers is not acceptable.
10. All protocols shall be "certified" by the governing authority, non-certified protocols are not allowed. If additional gateway, hardware, etc., is required to obtain the BACnet, Modbus, etc., interfaces, the VFD manufacturer shall supply one (1) gateway, hardware device, etc., per VFD. Multiple VFD's sharing one (1) gateway, hardware, etc., shall not be acceptable. BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs (BACnet Interoperability Building Blocks) defined by the BACnet standard profile for a B-ASC.
11. All wires to be individually numbered at both ends for ease of troubleshooting.

D. The following operation information displays shall be standard on the VFD digital display. The display shall be complete English words (alpha-numeric codes are not acceptable):

a. Output Frequency
b. Motor Current
c. Calculated Motor Torque
d. Calculated Motor Power
e. DC Bus Voltage
f. Output Voltage
g. Heatsink Temperature
h. Analog Input Values
i. Keypad Reference Values
j. Elapsed Time Meter
k. kWh Meter

E. The drive shall have the following field adjustments:

1. Five (5) programmable critical frequency lockout ranges to prevent the VFD from continuously operating an unstable speed.
2. PID setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. There shall be an independent, second PID loop that can be utilized to maintain setpoint of an independent process (i.e. valves, dampers, cooling tower bypass valve control, chilled water valve control, etc.
3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
4. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices.
5. Two (2) programmable analog outputs proportional to frequency, motor speed, output voltage, output current, motor torque, motor power, DC bus voltage, or active reference.
6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; maximum voltage 30
7. VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs must be true form "C" type contacts; open collector outputs are not acceptable.
8. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
9. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
10. The VFD shall ramp or coast to a STOP, as selected by the user.

F. Speed Command Input shall be via:

1. Keypad or manual speed control as selected by user.
2. Two (2) analog inputs, each capable of accepting a 0-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.
3. Analog inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be

able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20mA and 0-10 volts.

4. Floating point input shall accept a three-wire input from a Dwyer Photohelic, or equivalent type instrument.

2.2 USER SELECTABLE AUTOMATIC/MANUAL BY-PASS (Operation of motor at full voltage at 60 Hz fixed speed).

A. Input line fused disconnect (service switch) and/or fast acting fuses exclusive to the VFD will allow the VFD to be disconnected from the line prior to clearing upstream branch circuit protection to maintain bypass capability. Door inter-locked, pad-lockable circuit breaker will disconnect all input power from the drive and all internally mounted options, together with fully rated magnetic motor starters mechanically interlocked shall be used to transfer motor to line power. Transfer must occur in orderly fashion causing no component damage to either drive or motor. Manual bypass circuitry must be integral part of drive cabinet. Separate bypass or starter enclosure is not acceptable. The VFD shall be UL Listed by the drive manufacturer and UL508 label complete bypass assembly.

1. An output contactor, bypass contactor and VFD only disconnect/service switch and/or fuses will be provided. Overload protection shall be provided in both drive and bypass modes.
2. Provide user selectable manual or automatic bypass.
3. Bypass designs that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable, as a VFD input contactor is not a NEC recognized, lockable, physical disconnect and is an unacceptable means of safely disconnecting power to VFD.
4. The drive / bypass shall provide single-phase motor protection and under-voltage protection of bypass, contactor coils, etc., shall be in both the VFD and bypass modes.
5. The following operators shall be provided:

    a. Bypass HAND-OFF-AUTO.
    b. Drive mode selector.
    c. Bypass mode selector.
    d. Bypass fault reset]

6. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation: One mode forces the motor to bypass operation. The second mode as above also defeats all safeties and inputs (run until destruction).

B. Furnish auxiliary contacts to monitor drive status with FMS. A drive failure of any kind shall produce alarm signal and FMS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The drive shall be installed in strict accordance with manufacturer instructions. A minimum of 42" clearance shall be maintained in front of drives.

3.2 EQUIPMENT PROTECTION

A. Whenever possible drive shall be mounted within sight of motor that is controlled by drive. In the event that drive is not mounted within sight of motor, a disconnect will be installed (under Division 26) within sight of motor. If a disconnect is installed between motor and drive the drive supplier shall provide a 6" x 6" red engraved warning sign to be mounted at the disconnect which shall read as follows:

B. Drive shall include a coordinated AC transient protection system consisting of MOV's (Metal Oxide Varistors: phase-to-phase and phase-to-ground), a capacitor clamp, and 5% impedance reactors designed to protect itself against all normal transients and surges in the incoming power line, any grounding or disconnecting of its output power, and any interruption or run away of the incoming speed reference signal. Protection is defined as a normal shutdown with no component damage.

C. In general the drive shall contain the following protective circuits. In the case of a protective trip, the drive shall STOP, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).

1. Overcurrent trip 200% of the VFD’s variable torque current rating.
2. Overvoltage trip 130% of the VFD’s rated voltage.
3. Undervoltage trip 60% of the VFD’s rated voltage.
4. Ground Fault.
5. Adaptable Electronic Motor Overload (I2t). The electronic motor overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which protect the motor only at full speed are unacceptable.

3.3 OPERATING CONDITIONS

A. +/- 10% line voltage variations.

B. 5% incoming line frequency variations.

C. Maximum output frequency variations shall be +/- .25%.

D. FLA to meet or exceed UL/NEC table 430-150 of the minimum motor horsepower specified on the equipment schedule on the drawings.

E. Ambient temperature.

1. 0 to 50oC - NEMA 1 and 12 indoor enclosures: 1 thru 50 HP, 480 and 230 volt shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD musts be oversized.
2. 0 to 40oC - NEMA 1 and 12 indoor enclosures: 60 thru 550 HP, 480 and 230 volt, shall be capable of continuous operation; from 49 to 50 Deg. C (104 to 122 Deg. F.), VFD current derate as per VFD manufacturers documented/submittal data or VFD must be oversized.
3. 0 to 50oC - NEMA 3R outdoor enclosures inclusive of all HP and voltages shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD must be oversized.

F. Altitude.

1. 0 to 3300 feet above sea level without deration.
2. Derate per manufacturer’s recommendation for project elevations above 3300 feet.

G. 90% Maximum humidity (non-condensing).

3.4 TESTING AND DOCUMENTATION

A. Manufacturer to conduct standard factory tests to assure compliance with specification requirements.

B. Manufacturer’s local Designated Service Station's startup technician shall provide field startup and commission of all VFD's and shall demonstrate trouble free, stable operation for conditions of starting, full load, three quarter load, half load, quarter load, no load and intermediate loads. The local Designated Service Station shall have factory trained and certified applications engineer/service personnel to provide service, training and warranty onsite 24/365 (24 hours / 365 days per year) and a toll-free support line. Provide four (4) hours onsite training of programming and operation.

C. Field tests shall include 100 hours of operation under load to demonstrate adequacy of equipment under thermal and voltage stresses, and that harmonic and other interferences do not adversely affect the electrical instrumentation and communications systems.

D. Manufacturers technically qualified and factory trained representative to make final written documents of installation, inspection and test run.

E. Field testing to include demonstration of automatic restart under operation of the following existing controls:

1. Fire Alarm.
2. Nitestat.
3. OFF/AUTO Switch.
4. Clock Control.
5. FMS START/STOP in both VFD and BYPASS MODE.

F. Switching from bypass to VFD operation both manually and automatically that shall be user selectable.

G. Complete records of test procedure and results to be made available at no additional cost to purchaser's representative.

H. Equipment shall carry a two (2) year guarantee as to workmanship, material, and satisfactory functioning from date of startup or maximum of 30 months from date of shipment from factory.

I. Furnish complete sets of their drawings showing control schematics, transistor schematics, wiring, outline dimensions, mounting details and equipment weight.

J. Operating & Maintenance Data and Spare Parts List - Furnish copies of all instruction books, spare parts lists and special bulletins covering on-site installation and operation in accordance with Section 23 0500.

END OF SECTION 23 0550

SECTION 23 0593 – TESTING, ADJUSTING AND BALANCING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

A. Conform with applicable provisions of the General Provisions and the General Requirements.

B. Testing, adjusting and balancing (TAB) shall be performed by a TAB Agency which is independent of the Mechanical Contractor.

C. The TAB Agency's efforts shall be paid for by the Owner and shall not be included in the mechanical contract price.

D. Unless specifically noted, all work specified in this section shall be included in the scope of the TAB Agency's work. But some work described in this section is to be performed by the mechanical contractor, controls contractor, or others, and that work is specifically noted to be by these entities.

1.2 SCOPE

A. Provide TAB for the systems and equipment installed under Division 23, including but not limited to:

1. Supply and exhaust air systems including process and shops and laboratories systems.
2. Return air where specifically noted.
3. Hydronic systems including domestic HW return systems.

B. Provide all labor, instruments, and tools necessary to test, adjust and balance the systems shown on the drawings and/or described in these specifications. Check equipment performance, take measurements, adjust systems and equipment to provide specified performance, and report results. Submit reports to keep all parties posted on the progress of the TAB work.

C. Where the TAB effort indicates deficiencies in system performance, TAB Contractor shall take the lead in a collaborative effort to trouble-shoot and resolve these deficiencies. Engage the assistance of others where necessary, starting with the Mechanical Contractor and Controls Subcontractor. Take additional measurements as required to identify the cause of the deficiencies, perform additional TAB as required to bring the system in compliance with the design intent. Engage the assistance of the Engineer and others where necessary. Indicate final setpoints and readings in a final TAB report.

1.3 STANDARDS AND DEFINITIONS

A. Perform all work in accordance with these specifications and the latest edition of the NEBB Standards.

B. Air Handling Unit: Where the term Air Handling Unit (AHU) is used in this spec section, it shall include any factory fabricated or field erected unit that includes a fan and other components which filter, heat, cool, humidify or dehumidify the air stream. But the term AHU, where used in this section, does not include fan powered terminal units, fan coil units, unit heaters, cabinet unit heaters, etc.

C. Air Handling System: A fan or AHU and ductwork.

D. Hydronic System: A system in which a liquid is used to convey heat.

E. Record or Report: Where used as a verb, these terms mean to include in the TAB report.

1.4 QUALIFICATIONS

A. TAB agencies shall meet the following qualifications:

1. Membership in the Associated Air Balance Council (AABC), National Environmental Balance Bureau (NEBB) or the Testing, Adjusting and Balancing Bureau (TABB).
2. An office located within a 100 mile radius of the project site.
3. A minimum of five (5) years experience in the TAB field.

B. The following TAB Agencies are prior approved:

1. Energy Balance & Integration
2. Native Air
3. N-Demand Test and Balance LLC
4. Controls & Equipment Company

1.5 SUBMITTALS

A. Contractor shall submit the name of the proposed TAB agency prior to the TAB agency performing any services.

1. Submit a list of proposed personnel, including resumes with related project experience and certifications.
2. Submit proposed TAB procedures, instrumentation and measurement equipment including calibration data, and proposed sample TAB report forms.

B. Pre-Construction Report: Four weeks prior to the Mechanical Contractor installing the systems, the TAB Agency shall submit a letter indicating whether the design includes all devices the TAB Agency will need to successfully perform the TAB work. If any additional balancing devices are needed, the TABB Agency shall so note this in the pre-construction report.

C. Submit TAB reports as noted herein. Reports shall be in both hard copy and PDF format.

1.6 TAB PREPARATION AND COORDINATION

A. Mechanical Contractor shall perform the following in a timely fashion:

1. Provide the TAB Agency with the project documentation (drawings, specifications, bulletins, submittals, shop drawings, etc.) necessary to perform the TAB services.
2. Install, fill, pressure test, start up, clean, and the vent systems to be tested and balanced.

B. Controls Subcontractor shall perform the following in a timely fashion:

1. Install and make operational all necessary control systems and equipment, including computers and computer programs.
2. Provide qualified personnel to operate the systems as necessary to support the TAB effort. Provide the TAB contractor with the computer software necessary to facilitate the TAB effort.
3. Assist as required to resolve problems which become evident due to TAB work, and as required to obtain specified system performance.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Provide all equipment and instruments necessary to perform the work specified herein. Calibrate and maintain instruments per NEBB Standards. Provide not less than the following:

1. Pitot tubes and draft gauges.
2. Flow hood.
3. Velometer.
4. Thermometers.
5. Pressure gauges.
6. Flow meter test kit.
7. Ampere – voltmeter.
8. Speed indicator.
9. Sound meter to measure eight octave bands.

PART 3 - EXECUTION

3.1 GENERAL

A. Review and inspect the mechanical systems for conformance with design documents. Test, adjust and balance all system flows under design conditions and under other conditions where part load testing is specified. Comply with measurement tolerances per NEBB. Balance to within 10% of design flows unless otherwise specified.

B. Visually mark the final settings of balancing dampers, balancing valves, fan speed controls, etc.

C. Comply with NEBB Standards. The descriptions included herein are a guide to the minimum information needed.

D. Troubleshooting: In the event that any areas fail to get proper flow, take the lead in troubleshooting the system. Measure pressures, flows, etc. at various points throughout the systems as required to identify the cause of the deficiencies and identify upgrades which will

resolve these deficiencies. Coordinate any remedial efforts directly with mechanical and controls contractors and re-test as required.

3.2 TEST AND BALANCE REPORT

A. Report shall be 8-1/2" x 11" bound into a complete and coherent report, except that drawings may be larger size, but still bound into the report. All forms shall be typewritten or legibly handwritten.

B. Include the following sections in the order indicated:

1. Cover sheet with the Project Name, Location, and the names of the Mechanical Contractor and Engineer
2. Table of Contents
3. Summary indicating the highlights of the report and summarizing any deficiencies and recommendations
4. Test results including the names of the persons performing the tests and dates the tests were performed
5. Drawings
6. Description of the test procedures used
7. List of instruments used along with their calibration data
8. Qualifications of personnel

C. Submit five copies and a PDF of the complete TAB report minimum two weeks before the first O&M instruction session. One copy will be returned to the Contractor with review comments.

3.3 BASIC AIR HANDLING SYSTEM TESTING, ADJUSTING AND BALANCING

A. General

1. Test all fans and air handling systems. Balance systems to achieve specified air flows while minimizing throttling losses.
2. Air Flow Measurements: Fan and AHU flow rates may be determined by pitot tube traverse or by measuring fan speed, suction and discharge pressures, and comparison with the fan curve. Measure duct air flows using pitot tube traverses. Measure air flows of grilles, registers and diffusers using either capture hoods or pitot tube traverses in the connected ductwork. Make such other tests as may be required to demonstrate that systems perform per the design requirements.
3. Air Flow Measuring Stations: Calibrate each air flow measuring station which is provided as part of the construction contract. Use duct pitot tube traverses or other appropriate means to measure air flows. Coordinate with the flow measuring station supplier, and enter calibration coefficients into the FMS. Record the results of this effort.
4. Alert Mechanical Contractor and Engineer if any fan or air handling unit (AHU) appears to be operating in an improper or unsafe condition.
5. Seal all test holes in ductwork once testing is complete. Repair insulation jackets to maintain the integrity of the vapor barrier.
6. Include in the report copies of ductwork drawings with test points indicated.
7. Variable Flow Systems: Verify proper fan tracking from full flow to 50% flow.

B. Fans: Perform the following for all fans, including those provided as part of an AHU.

1. Fan Nameplate: Record unit number per the equipment schedule, manufacturer, model, size, and serial number.
2. Performance Data: Measure air flow and adjust fan speed to achieve required flow. Record air flow, static pressure rise and fan speed.

    a. Advice when belt and/or sheave changes are required to achieve the design flows. Mechanical contractor shall make the necessary changes as part of the mechanical contract. Approximately 25% of fans may require a sheave and/or belt change.

3. Current and Voltage: Record motor nameplate and measured voltage and amperage. Advise if motor amps exceed rated load amps.

C. Air Handling Units:

1. Outside Air: Test outside air flows using a pitot tube traverse and balance as required. If a traverse is not practical, use the mixed air temperature method if the inside and outside temperature difference is at least 20 deg F, or use the difference between pitot tube traverses of the supply and return air ducts.
2. Static Pressure: Measure and record the static pressure at the inlet and outlet of each AHU component, including louvers, dampers, filters, coils, etc, and at each inlet and discharge duct connection.

D. Coils: Measure and record air and water flows and pressure drops.

E. Air Distribution Systems:

1. Zone, Branch and Main Ducts:

    a. Adjust to within 10% of design air flows. Balance so that at least one zone balancing damper is wide open. Balance multi-diffuser branch ducts so that at least one outlet or inlet damper is wide open.

2. Air Terminal Units:

    a. Calibrate flow sensors and enter design maximum and minimum flow setpoints into FMS.
    b. Record terminal unit number, size, specified flow, agency measured flow, FMS measured flow, and DDC flow correction factors.

3. Diffusers, Registers and Grilles:

    a. Test, adjust, and balance each diffuser, grille, and register to within 10% of specified design requirements. Record the size of each grille, diffuser, and register, initial flow measurement, and final measured flow.
    b. Where rooms are indicated to be maintained at either positive or negative pressure, balance air flows to achieve these conditions under design flow conditions, and verify proper pressurization at minimum flow.

F. Fan Coil Units, Unit Heaters, Cabinet Unit Heaters, Air Curtains, Door Fans, Fan Powered Terminal Units and other devices with fans and coils:

1. For each unit, record unit number, manufacturer, model, size, motor HP, voltage and rated load amps and design air flow.
2. Measure and record initial air flows, along with final air flows, unit inlet and outlet static pressures, voltages, and motor amps.
3. Measure and record initial and final water flows and pressure drops.

G. Energy Recovery Units:

1. For each unit, record unit number, manufacturer, model, size, motor HP, voltage and rated load amps and design air flow.
2. Measure and record initial air flows, along with final air flows, unit inlet and outlet static pressures, voltages, and motor amps.

H. Duct Leakage Testing

1. Specification Section 23 3000 describes the requirements for duct leakage testing. Provide all instrumentation and labor to take the required measurements.
2. The Mechanical Contractor shall provide the fans and all other required work.
3. Submit test report. Retest until ductwork complies with specified leakage criteria.

3.4 HYDRONIC SYSTEMS

A. General:

1. Prior to commencing hydronic balance:

a. Set valves to proper position per the sequence of operation. Open all coil valves to full open position. Set 3-way valves to full flow through system component.
b. Check pump rotation.
c. Verify that system is adequately pressurized.
d. Set temperature controls so all system components deliver maximum flow.
e. Balancing may be done in sections.

2. Pumping Systems: Measure flows and determine operating characteristics of hydronic systems with pumps operating both independently and in parallel (where applicable). Make measurements at maximum flow.
3. Balance systems to minimize throttling out in the distribution, and to instead throttle at the pump discharge. Recommend impeller trimming if appropriate.
4. Measure and report performance readings on all pumps, coils, heat exchangers, heating and cooling water generating equipment, flow measurement devices, heat rejection equipment, etc. Measure and record the following for each item of hydronic equipment

Eqpt Type		Pumps (Note 1)	Chillers	Air Cooled Condensers	Cooling Towers	Hot Water Boilers	Steam Boilers	Heat Exchangers	Coils			
Tag No.		X	X	X	X	X	X	X	X			
Nameplate Data	Mfgr	X	X	X	X	X	X	X	X			
	Model	X	X	X	X	X	X	X	X			
	Serial	X	X	X	X	X	X	X	X			
	Volts	X	X	X	X	X	X					
	RPM	X	X	X	X	X	X					
	HP	X			X							
	FLA	X	X	X	X	X	X					
	Refrigerant		X	X								
Scheduled	GPM1	X	X		X	X		X	X			
	Press Drop	X	X		X	X		X	X			
	GPM2		X					X				
	Press Drop		X					X				
Measured	GPM1	X	X		X	X		X	X			
	Inlet Press	X	X		X	X		X	X			
	Outlet Press	X	X		X	X		X	X			
	Press Drop	X	X		X	X		X	X			
	GPM2	X	X					X				
	Inlet Press	X	X					X				
	Outlet Press	X	X					X				
	Press Drop	X	X					X				
	Volts	X	X	X	X	X	X					
	Amps	X	X	X	X	X	X					

Notes
1 For pumps measure pressure rise instead of pressure drop. Measurements for GPM2 shall be at shutoff conditions.

5. Domestic HW return system: Balance to ensure HW availability throughout the system. Where balancing valves are provided, record flow and balance to provide flow in each circuit.

3.5 LIMIT DEVICES AND SAFETY CONTROLS

A. Limit Devices: Check all limit devices to verify proper operation, including, freezestats, flow switches, etc. Include in the TAB report a list of all such devices and the results of their tests.

B. Fire and Smoke Dampers

1. Test each fire damper, smoke damper, and fire/smoke damper to ensure proper operation. Record test results.
2. Fire Dampers: Open access door, disconnect fusible link or activate thermal link, and verify that damper closes smoothly and completely. Reset damper and access door.

3. Smoke Dampers: Open access door, activate damper, observe whether it closes smoothly and completely, and measure closing time. Reset damper and verify it opens completely. Close access door and record test results.

C. Life Safety Controls: Test and record life safety control operation of the HVAC systems. Verify the installation of required smoke detectors in air handling equipment, and verify operation of the smoke detector by activating the smoke detector and observing air handler shutdown or other required functions as described on the control drawings and sequence of operation. With assistance from the contractors for mechanical, temperature controls and electrical work, verify the operation of interconnected systems, such as the smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequence.

3.6 SOUND TESTING

A. Measure sound level in approximately ten percent of rooms as directed by Engineer.

1. Shut off mechanical equipment and measure background sound level in each octave band.
2. Start mechanical equipment and measure sound level in each octave band.
3. Submit a plot of measured data against noise criteria (NC) curves.

B. Where measured sound levels are deemed by Owner to be unacceptable, work with Engineer and Mechanical Contractor to reduce actual levels, and retest as required.

3.7 AIR HANDLING SYSTEMS – SPECIAL APPLICATIONS

A. Rooms Requiring Air Flow Tracking and/or Active Room Pressure Control:

1. Calibrate flow sensors for all supply and exhaust air devices serving the room, and enter design maximum and minimum flow set points into FMS.
2. Calibrate room pressure sensor.
3. Verify proper air flow tracking and room pressure control as the system operates from maximum to minimum, and back to maximum flow.
4. Submit a separate sheet in the report for each such room. Include an air flow diagram showing each device in the air flow and control system, and record all pertinent design and measured data on this sheet, including but not limited to:

    a. Air valves: Tag number, size, specified flow, agency measured flows and FMS measured flows at various flow conditions, and DDC flow correction factors.
    b. Offset air flows and room pressures at various flow conditions.

B. Rooms to be Balanced to a Positive or Negative Pressure (Without the Use of Air Flow Tracking or Active Pressure Controls):

1. Balance supply and return air flows as required
2. Crack open the door and use a smoke puffer to demonstrate the direction of air flow. Test under maximum and minimum flows. Record test results.

C. Room Tightness Testing:

1. Where a room tightness test is specified, provide the instrumentation and labor to perform such test.
2. The Mechanical Contractor shall provide the fans and associated ductwork for the test.
3. Submit test report. Retest until room complies with room leakage criteria.

D. Fume Hoods and Shop's Capture Hoods: Test exhaust airflow by duct pitot tube traverse, and adjust exhaust air valve to control to within 5% of design flow. Balance makeup air flows as specified above. Test for turbulence and proper air flow patterns at the face and inside hoods using a smoke puffer or other approved smoke-emitting device. Document the test results, and advise of any concerns and recommendations.

E. Building/Zone Pressurization: Test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differential. For positive pressure areas, set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

END OF SECTION 23 0593

SECTION 23 0700 – MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 3000, Air Tempering System and Equipment.

1.3 SCOPE

A. Field insulation of piping see drawings and Part 3 of this specification.

B. Field insulation of ductwork: See drawings, Table 23 0700-1, and Part 3 of this specification.

C. Field insulation of equipment supplied and/or installed under Division 23; See drawings and Part 3 of this specification.

D. Factory-insulated equipment and materials are de3scribed on the equipment schedule, on the drawings, and in other sections of this specification.

1.4 SUBMITTALS

A. Submit products to be used including insulation, jackets, miscellaneous products, and products for special applications Review each application and advise if any product is either not suitable for, or not recommended for the application.

B. Verify that each submitted product meets all requirements for that product as specified herein. Include literature that clearly shows products meet all aspects of the spec. Include a cover sheet or letter with the following statement:

> "Each product submitted here meets all specified requirements for that product except as follows." Follower by a list of any discrepancies.

C. Submit schedules showing the type of product and thickness for each application. Indicate products to be used on valves and fittings. Indicate where vapor barriers will be provided and what jackets will be used.

D. D-5, D-6 & D-7 insulation: If one of these insulations is specified, submit documentation indicating that the submitted materials are approved for the intended service.

E. Submit a description of the application techniques to be used.

1.5 QUALITY ASSURANCE

A. Comply with the latest edition of the National Commercial & Industrial Insulation Standards, as published by the Midwest Insulation Contractors Association.

B. Part 3 and Table 23 0700-1 give the system temperatures for various applications. Supplier shall review these temperatures and confirm the suitability of all components for the specified applications.

C. Test piping and ductwork in accordance with applicable specification sections before insulation is applied.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials must be 100% asbestos-free and 100% formaldehyde-free, NO EXCEPTION.

B. All materials must be GreenGuard Gold Certified.

C. Smoke and Fire Ratings: All materials shall have a composite fire and smoke hazard rating not exceeding flame spread 25, fuel contribution 50, smoke developed 50, when tested as assemblies per ASTM Standard E-84 or NFPA 255.

D. Thermal conductivities: Per ASTM C518. Do not exceed the conductivities indicated. Units listed herein for conductivity are Btuh-in/SF-F. Resistance shall not be less than the values specified herein. Units for resistance are SF-F/Btuh.

E. Noise Reduction Coefficients: Per ASTM C423 based on Type A mounting. NRC shall not be less than as specified.

F. Jackets: Maximum 0.02 perm water vapor transmission per ASTM E96 Procedure A.

1. ASJ: All service jacket per ASTM C1136 Type I, paintable white kraft paper outer surface reinforced with glass fiber yarn and bonded to aluminum foil, with self-sealing longitudinal lap and butt strips, breach puncture min. 50 oz-in/in tear per ASTM D781, tensile strength min. 30 lb/in per ASTM D828.
2. FSK: Foil skim kraft per ASTM C1136 Type II.

G. Fiberglass insulation: Inorganic fibers bonded with thermosetting resin.

H. Approved Manufacturers: Owens Corning, Johns Manville, Knauf, Certain-Teed, Kflex, Armacell, Unifrax -Insulfrax, Industrial Insulation Group, Pittsburgh Corning. Where the term

OAE is used herein, this refers to these manufacturers only. No other manufacturers are approved for this project.

2.2 PIPE INSULATION

A. General

1. Valves, Fittings, and Accessories: Use the same insulation materials and thickness as the pipe insulation, except as noted.

B. Type P-1, Fiberglass Pipe Insulation: Factory assembled insulation and ASJ. Pre-formed fiberglass per ASTM C547 Type I, suitable for use on surfaces from 0–850oF, with thermal conductivity 0.23 at 75oF or 0.33 at 250oF, and minimum 3 pcf density. ASJ shall have self-sealing lap at end and along length, with pressure sensitive tape lap sealing system. Owens Corning SSL II Pipe Insulation, Johns Manville Micro-Lok, Knauf Pipe Insulation.

1. Where Type P-1 insulation is used, insulate fittings, valves and accessories using one of the following:

a. Fiberglass pre-formed fitting insulation complying with the specification for P-1 pipe insulation, Johns Manville Hi-Lo Temp insulation inserts, Hamfab, OAE. Finish with Type J-2 fitting covers.
b. Where pre-formed fitting insulation is not available, the following may be used: minimum 0.75 pcf density fiberglass per spec for D-1 insulation except without FSK. Finish with Type J-2 fitting covers or with two coats of fitting mastic with fiberglass fitting tape embedded between coats.

C. Type P-2, Fiberglass Pipe and Tank Insulation: Similar to Type P-1 insulation and jacket, except with fibers oriented to allow insulation to be wrapped onto curved surfaces, with conductivity 0.30 at 100oF, or 0.55 at 400oF. Johns Manville Pipe & Tank Insulation, Owens Corning Pipe and Tank Insulation or Knauf Pipe and Tank Insulation.

1. Alternate: Fiberglass board insulation similar to Type D2, scored for application on curved surfaces, with ASJ.

D. Type P-3, Calcium Silicate Pipe Insulation: Rigid calcium silicate per ASTM C533, Type 1, asbestos-free, suitable for use on piping up to 1200oF, conductivity 0.55 at 700oF, compressive strength min. 200 psi at 5% compression. Industrial Insulation Group OAE.

1. Fittings, valves and accessories: Insulate with mitered Type P-3 insulation or Type D-7 insulation.

E. Type P-4, Elastomeric Foam Pipe Insulation: Pre-formed elastomeric foam, ASTM C534 Type 1 flexible, closed cell, suitable for use up to 220oF, UV protected, not to exceed flame spread 25 and smoke developed 50 based on 0.75-inch thickness, conductivity 0.30 at 75oF. Kflex, Armacell OAE.

1. Fittings, valves and accessories: Insulate using either Type P-4 insulation pre-formed for use on fittings and valves, or cut sections of P-4 pipe insulation to match the shape of the fitting or valve, taped on using PVC tape.

2.3 DUCTWORK INSULATION

A. Type D-1, Fiberglass Blanket: Factory fabricated insulation and FSK jacket assembly suitable for applications from 40-250oF, 3/4 pcf fiberglass, ASTM C553 Type I or II, with thermal resistance not less than the following for 2-inch thickness: 6.8 out of the box, 5.6 installed with 25% compression. Johns Manville Microlite XG Duct Wrap, Owens Corning Soft R Duct Wrap, Knauf Friendly Feel Duct Wrap, Certainteed Soft Touch Duct Wrap.

B. Type D-2, Fiberglass Board: Similar to Type D-1 except rigid board type, 3 pcf density, thermal conductivity 0.23 at 75oF, NRC 1.36, suitable for unfaced side at up to 450oF and faced side at up to 150oF. Johns Manville 800 Series Spin Glas, Owens Corning 700 Series Board, Knauf Insulation Board, Certainteed Certra Pro Commercial Board

C. Type D-3, Acoustic Lining (roll type): Does not apply to this project.

D. Type D-4, Acoustic Lining (board type): Does not apply to this project.

E. Type D-5, Grease Duct Applications: High temperature, foil-encapsulated inorganic blanket, 8 pcf. Insulfrax Fyre Wrap Max 2.0, Johns Manville Fire Temp, OAE. Product shall meet the following when applied as 2-layers around a grease-duct:

1. Tested and listed for zero clearance to combustibles across the entire surface of the blanket material per internal fire test AC101 or ASTM E2336 - Internal Fire Test – 2 Hr Grease Duct Enclosures.
2. Rated as a 2-hr fire resistive enclosure assembly per ASTM E-119, Engulfment Fire Test for 2-hr Grease Duct Enclosure.

F. Type D-6 –Combustible Materials within Plenum: For use on combustible materials located within supply or return air plenums, foil-encapsulated 8 pcf high-temperature ceramic fiber blanket suitable for service up to 1800oF. Unifrax Fyre-Wrap 0.5 plenum insulation.

G. Type D-7 – Fire Rated Ductwork: Suitable for continuous operation at 1800oF, 6-pcf, foil-encapsulated inorganic blanket to provide a 2-hour rating per ISO 6944 when applied in a single 1.5-inch thick layer. Insulfrax FyreWrap 1.5 OAE.

H. Type D-8 – Polystyrene Insulation: Rigid cellular square edge insulation per ASTM C578, waterproof, thermal conductivity 0.20, compressive strength 25 psi. Dow Styrofoam or Owens Corning Foamular.

I. Type D-9 – Fiberglass Ductboard: Listed per UL 181 as a Class 1 Rigid Air Duct; conforming to ASHRAE Std. 62, NFPA-90A and 90B, ASTM G-21 & G-22; rated for 2-in. wg; constructed of fiberglass bonded with a thermosetting resin, with double density slip joints pre-molded in the board; FSK jacket; thermosetting acrylic polymer interior surface, and black interior surface color. Thermal conductivity 0.23, and NRC 0.70 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Superduct 475 or 800, Owens Corning Quiet R Duct Board, Knauf Duct Board M, Certainteed ToughGard Duct Board

2.4 EQUIPMENT INSULATION

A. E-1, Removable Insulating Blanket: Factory fabricated, one-piece, removable and re-usable insulating blanket with fiberglass insulation completely enclosed within a silicone coated fiberglass cloth with draw cords of SS or PTFE coated glass fiber, and stainless steel clips. Insulation thickness shall be as specified elsewhere, but not less than 1-inch. Energy Systems Inc. "Q-Master" OAE.

2.5 INSULATION JACKETS

A. Type J-1, Metal Jacket: 0.010-inch smooth Type 304 stainless steel or 0.016-inch smooth or embossed aluminum per ASTM B-209, with minimum 1-mil polyethylene film with protective layer of 40 Lb virgin kraft paper, continuously laminated to full width inside jacket. Childers OAE.

1. Where jacket diameter is 16–96 in: 0.016-in. SS or 0.020 in. aluminum.
2. Equipment heads and all surfaces where jacket is greater than 96-inch OD: 0.020-inch SS or 0.024 inch aluminum.
3. Fittings and Accessories: Provide the same jacket material as for pipe.

B. Type J-2, PVC Jacket: Minimum 20 mil sheets and 30-mil pre-molded fitting covers, ASTM D1784, Class 16354-C. Accessories include solvent weld solution, stainless steel tacks, and tape. All components shall be white, UV resistant, with paintable exterior surface, and suitable for use at –20 to +150oF. Johns Manville System 2000 (sheets), Zeston 300 (fitting covers), and Perma-Weld (solvent cement), OAE.

C. Type J-3, Canvas Jacket: 10 x 10 fiberglass mesh.

2.6 MISCELLANEOUS PRODUCTS

A. General:

1. Tapes: Aluminum, pressure sensitive, UL 181A-P listed and embossed, minimum 2.5- inch wide, Nashua 324A OAE.
2. Duct Liner Adhesives: Water-based, complying with ASTM C916.
3. Solvent Cement for PVC Jackets: Johns Manville Perma-Weld OAE.
4. Staples: Outward clinching, 0.5-inch galvanized steel

B. Piping Systems:

1. Pipe Hanger Insulation Inserts: Mechanical Pipe Shields Inc. "Snapp Itz" OAE.

C. Ductwork Systems:

1. Duct Liner Edge Sealer, Surface Sealer, Coatings & Adhesives: To meet ASTM C916. Johns Manville Superseal OAE.

2.7 SPECIAL APPLICATIONS

A. Handicap Lavatory Insulation Kit: Handi-Lav-Guard insulation kit per ANSI A117.1 with flexible vinyl finish.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage and Handling: Deliver and store insulation materials in factory-supplied containers. Protect from moisture. Do not install any materials that have gotten wet, regardless whether they are subsequently dried.

B. Store and apply materials in accordance with manufacturers' recommendations, but not less than the following minimum temperatures. Ensure surfaces are clean and dry prior to application, and for minimum two hours after application:

1. Sealers, coatings, solvents and adhesives: 40oF.
2. Tapes 50oF.

C. Install in accordance with manufacturer's recommendations, NAIMA recommendations, and this spec. Provide good ventilation.

D. Where vapor barriers are specified, ensure that the entire system is vapor sealed.

E. Protect materials from water damage. Replace any materials that are water-damaged prior to substantial completion.

3.2 PIPING INSULATION

A. General: Insulate piping as indicated herein and/or on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings and accessories. Vapor seal cold piping systems.

1. Where insulation terminates, provide insulating cement beveled for a neat finish. For vaporsealed piping, coat with insulating mastic prior to applying insulating cement.
2. Strainers and Suction Diffusers: Either Type P-1 or P-3 insulation. Make provisions to easily remove and re-install insulation.
3. Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.
4. Penetrations Through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.

5. Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.
6. Steam Traps: Do not insulate.
7. Retrofit Projects: Match the thickness of existing insulation where new insulation adjoins existing. Integrate new vapor barrier with existing so the insulation barrier is continuous for both new and existing piping.
8. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

B. Application:

Temp Range	Temp (F)	Insulation Type	Vapor Sealed	Pipe Size				
				Under 1	1 - 1.5	Over 2 - 3	4 & 6	8 & Larger
TR-1	60&Less	P-1 or P-4	Yes	1.5	1.5	1.5	1.5	1.5
TR-2	61 – 104	P-1	Yes	0.5	0.5	0.5	0.5	0.5
TR-3	105 - 140	P-1	No	1.0	1.0	1.0	1.0	1.0
TR-4	141 - 200	P-1	No	1.5	1.5	2.0	2.0	2.0
TR-5	201 - 250	P-1	No	1.5	1.5	3.0	3.0	3.0

1. Temperature Range TR-1: Chilled water, refrigerant suction, condenser water (outdoor piping subject to freezing).
2. Temperature Range TR-2: Domestic cold water, makeup water, soft water, process water of any type, non-potable water, HVAC make-up water (except insulation is not required for evap cooler makeup piping outdoors), interior horizontal roof drain and overflow bowls and piping, condensate drains indoors.
3. Temperature Range TR-3: Domestic hot water (including non-circulating HW within interior walls and chases) and domestic HW return except as noted.
4. Temperature Range TR-4: Heating water supply and return, low pressure steam condensate, and pumped condensate return.
5. Temperature Range TR-5: Low pressure steam, blowoff, medium and high pressure steam condensate return.

C. Special Applications

1. Handicap Lavatories: Insulate domestic hot and cold water piping and P-traps exposed below handicapped lavatories with insulation kit specifically designed for the application.
2. Heat Traced Piping: Oversize insulation as required to accommodate heat tracing. Provide metal jacket.
3. Plastic pipe in return air plenums: Provide 0.5-inch type D6 insulation.
4. Piping subject to freezing and heat traced piping: Insulate all such piping (including drain piping) with thicknesses specified, but not less than 1.5-inch thickness. Oversize insulation to accommodate heat tracing where indicated. Provide J1 jacket.
5. Steam PRVs: Provide 1.5-inch type E1 insulation.

D. Type P-1 & P-2, Fiberglass Insulation: Install in accordance with manufacturer's recommendations.

E. Type P-3, Calcium Silicate Insulation: Adhere to pipe or equipment using stainless steel wire. Provide removable J-1 jacket.

F. Type P-4, Elastomeric Foam: Seal all butt ends and longitudinal joints with Halstead Adhesive. When exposed to the weather, protect flexible tubing insulation with two coats of exterior weatherproof coating as recommended by manufacturer.

G. Jacketing: In addition to the finish and jacket specified for the particular type of insulation, provide the following:

1.	Indoor piping exposed to physical damage	Type J-2, PVC
2.	Mechanical Eqpt Spaces: Exposed piping less than 8 ft above floor	Type J-2, PVC
3.	Exterior piping/Inside Air-handler	Type J-1, Metal
4.	Tunnels	Type J-2, PVC

3.3 DUCTWORK INSULATION

A. General:

1. Insulate all ducts except those specified to be uninsulated. The following ductwork need not be field insulated:

    a. Factory insulated ductwork and plenums.
    b. Ducts with acoustic lining: Does not apply to this project.
    c. Exhaust ducts, except where noted.
    d. Return air ducts, except where noted.

2. See Table 23 0700-1 for additional information.
3. Ensure that ductwork is leakage tested prior to applying insulation. Inspect ductwork and repair any deficiencies prior to applying insulation. Do not apply insulation over deficient ductwork or plenum construction.
4. Ensure that ductwork is clean and dry before applying insulation.
5. For ductwork with acoustic lining the drawings indicate the "clear inside duct dimension" required. Over-size ducts as required to provide the required air flow area.

B. Type D-1, Fiberglass Blanket Insulation: Measure and cut insulation. Install so insulation is not excessively compressed at corners. For rectangular and flat oval ducts 24-inches and wider, provide stick pins and speed clip washers 18-inches on centers on the bottom, and clip off excess length of stick. Firmly butt insulation ends and longitudinal joints. Overlap jacket minimum 2-inches at end joints and longitudinal joints, staple on 6-inch centers, and continuously seal jacket. Provide vapor barrier mastic where ducts are indicated to be vaporsealed. Should gaps or fishmouths occur, re-staple and seal them with mastic. Use FSK tape and vapor barrier mastic to seal all penetrations of the FSK jacket, such as pins, tears, and hangers. Neatly trim and seal insulation at access doors, ends, damper rod controls etc. Verify proper damper operation.

C. Type D-2, Fiberglass Board Insulation: Attach with mechanical fasteners 12" on centers.

D. Type D-3 & D4, Acoustic Lining: Does not apply to this project.

E. Type D-5: Install insulation in a 2-layer system per manufacturer’s instructions, including the use of mechanical fasteners for the underside of ducts, butting or overlapping of joints, and offsetting of joints on outer layer.

F. Type D-6: Install in accordance with manufacturer's instructions. Overlap seams and joints minimum 2-inches, affix with SS wire minimum 18-inches on centers, but not less than per manufacturer's recommendations, and tape seams and joints with aluminum tape.

G. Type D-7: Install insulation in a single-layer system per manufacturer's instructions. Mechanical fasteners for the underside of ducts shall be adhered to the duct in a manner suitable for the operating temperatures (welded or other suitable method). Butt or overlap joints per manufacturer's recommendations.

H. Type D-8: Wire in place with SS wire minimum 12-inches on centers, and provide J-1 jacket.

I. Type D-9: Install per manufacturer's recommendations, NAIMA standards, and SMACNA Fibrous Glass Duct Construction Standards. Provide ship lap seams and joints.

3.4 EQUIPMENT INSULATION

A. General: Where specified elsewhere, equipment will be factory insulated. Insulate all equipment as noted herein except portions of equipment that are factory insulated.

1. Fiberglass Board Insulation: Score, bevel, or miter to provide tight joints and secure in place with mechanical pin and clip fasteners and insulation bonding adhesive applied to underside surfaces, or with bands. Fill joints with insulation material and provide corner beads to protect edges of insulation.
2. Cold Tanks and Equipment: J3 jacket with two coats of approved vapor barrier mastic.
3. Factory Packaged Equipment: Field insulate the equipment and piping on factory-fabricated assemblies as if they were field installed, unless such items are factory insulated.

B. HW Pumps: Do not insulate.

C. Condensate Receivers: 1.5-inch Type D-2 or P-2 insulation with J-1 jacket.

D. Shell and Tube Heat Exchangers for Hot Service: 2-inch Type P-1 or P-2 insulation.

E. Plate and Frame Heat Exchangers for Hot Service: 2-inch Type D2.

F. Storage Tanks: 2-inch type P2.

3.5 JACKETING

A. Type J-1, Metal Jacketing:

1. Ducts: Slope jacketing to shed rain.
2. Pipes: Install with seams at the 3 o'clock or 9 o'clock position to shed water. Band 12" on centers.
3. Joints and Seams: Overlap joints minimum 2-inches. Caulk with a weatherproof caulk when located outdoors.

B. Type J-2, PVC Jacketing: Secure in place with tacks and solvent welded joints. White PVC tape may be used indoors.

C. Type J-3, Canvas Jacket: Apply mastic at a rate of 60 to 70 sq. ft. per gallon, embed fiberglass mesh, smooth all wrinkles and apply finish coat of Sealfas, or equivalent.

TABLE 23 0700-1 ─ DUCTWORK INSULATION

Service	Location	Condition	Insulation Type	Insulation Thickness (in)	Notes
Supply Air, Makeup Air, Outside Air	Indoor	Concealed	D1	2.0	1, 6
Supply Air, Makeup Air, Outside Air	Indoor	Exposed	D2	2.0	
Supply Air, Makeup Air, Return Air	Outdoor	All	D8	2.0	2, 4, 7
Supply Rectangular Ductwork downstream of Terminal Units, Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	Indoor	All	D1	2.0	1, 3
Return Rectangular Ductwork upstream of Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	Indoor	All	D1	1.5	3
Ductwork indicated to be lined	All	All	D3	1	5
Ductwork indicated to be lined with 2-inch acoustic lining	All	All	D3 or D4	2	5
Single Wall Lined Plenums	All	All	D4	2	
Transfer Air Ducts	All	All	D3 or D9	1	
Exhaust Ductwork	Indoor	Concealed	D1	1.5	8
Exhaust Ductwork	Indoor	Exposed	D2	1.5	8
Kitchen Exhaust Ductwork	Indoor	All	D5	2-layers	
Plastic Piping and Ductwork within RA Plenums	Indoor	Concealed	D6	0.5	
Fire-Rated Ductwork Other than Kitchen Exh	Indoor	All	D7	1.5	
Boiler Breeching & Stack	Indoor	All	P1 or P2	3	
Boiler Breeching & Stack	Outdoor	Exposed	P1 or P2	3	4, 7

Notes:

1. Includes Supply Air Duct from Energy Recovery Units and Evaporative Coolers.
2. In this project duct lining is not permitted for use in air handling equipment and duct systems.
3. In general, insulation is not required on return ductwork if located in an indirectly conditioned space such as a ceiling plenum space. Provide type D3 insulation in duct if indicated to be lined on the plans or installation details.
4. Provide J1 Jacket.
5. In hospitals do not provide acoustical lining in supply ductwork or plenums downstream of the final filter.
6. Vaporseal ducts conveying cold air.
7. Seal outdoor ductwork to prevent ingress of moisture.
8. Insulate only the portion of exhaust ductwork between isolation damper and outside.

END OF SECTION 23 0700

SECTION 23 0800 - MECHANICAL FACILITY STARTUP/COMMISSIONING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope Of The Work

1. The purpose of this section is to specify Division 23 responsibilities and participation in the commissioning process. The owner will hire the Commissioning Authority for the project.
2. The Owner will hire the HVAC test and balance firm as denoted in Section 23 05 93. The Commissioning Authority will coordinate the activities of the HVAC test and balance firm.
3. The Contractor is responsible to provide support required for start-up, testing, and commissioning. The commissioning process requires significant participation of Division 23 to ensure all portions of the work have been completed in a satisfactory and fully operational manner.

B. Minimum requirements for Contractor:

1. Start-up and testing of the equipment supplied.
2. Operate and maintain equipment and systems as required for commissioning tests.
3. Providing qualified personnel including equipment manufacturer's service technicians for participation with the commissioning team.
4. Provide equipment, materials, and labor necessary to correct deficiencies found during the commissioning process, which fulfill contract and warranty requirements.
5. Provide operation and maintenance information and record drawings for verification, organization, and distribution.
6. Provide assistance to the Commissioning Authority (CA) to develop and edit equipment startup and testing schedules (Commissioning Matrix).
7. Provide training for the systems specified in this division with coordination by the Contract Administrator and Commissioning Authority.
8. Attend commissioning meetings.

1.2 RELATED WORK

A. All start-up and testing procedures and documentation requirements specified within Division 23.

B. Allow sufficient time before final commissioning dates so that testing, adjusting and balancing can be accomplished.

C. Put all heating, ventilating, and air conditioning equipment and systems into full operation and continue the operation during each working day of testing, adjusting and balancing and commissioning.

D. Provide labor and material to make corrections when required.

1.3 DEFINITIONS

A. Point Verification Forms (PVF) are detailed installation and startup tracking documents developed by the Commissioning Authority and completed through a cooperative effort between the Contractor and the Commissioning Authority. The PVFs will track each point through installation, termination, and connection to the Facility Management System (FMS).

B. Functional Performance Tests (FPT) are detailed testing procedure developed by the Commissioning Authority, and conducted through a cooperative effort between the Contractor and the Commissioning Authority. The FPTs will be detailed step by step procedures developed for each HVAC system. Each FPT will have a clear acceptance criteria based in the contract documents which must be achieved before the system or sub-system is accepted by the Commissioning Authority and the Owner.

C. The Commissioning Authority (CA) is a firm hired directly by the Owner to oversee the entire commissioning process.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the system can be started, tested, adjusted, balanced, and otherwise commissioned. Division 23 has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are fully functional and ready for startup and testing. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.

B. A commissioning plan will be developed by the CA and approved by the commissioning team. Division 23 is obligated to assist the CA in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If system modifications/clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner. If Contractor initiated system changes have been made that alters the commissioning process, notify the Commissioning Authority and Contract Administrator for approval.

C. Specific pre-commissioning responsibilities of Division 23 are as follows:

1. Bring each system into a fully operational state. This includes cleaning, filling, purging, leak testing, motor rotation check, control sequences of operation, full and part load performance, etc as required. The TAB firm will not begin the TAB work until each system is complete, including normal contractor start-up. The CA will not initiate FPTs until each system is complete, including normal contractor start-up and the TAB work has been completed.

D. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems, or sub-systems, and will be coordinated with the CA. Start of commissioning before system completion will not relieve Division 23 from completing those systems as per the schedule.

3.2 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start up all systems within Division 23. These same technicians shall be made available to assist the CA in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested, coordinated by the CA, and tracked on the Commissioning Matrix. Division 23 will ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustment, and/or problem resolutions.

B. System problems and discrepancies may require additional technician time or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Contract Administrator and CA reserve the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the commissioning team to complete the job.

3.3 WORK TO RESOLVE DEFICIENCIES

A. In some systems, misadjustment, misapplied equipment and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work will be completed under the direction of the Contract Administrator, with input from the Contractor, equipment supplier, and CA. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Contract Administrator will have final jurisdiction on the necessary work to be done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit completion of the commissioning process according to the schedule. Experimentation to render system performance will be permitted. If the CA deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the CA will notify the Owner indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.4 TRAINING

A. Participate in the training of the Owner's engineering and maintenance staff, as required in Divisions 23, on each system and related components. Training, in part, will be conducted in a

classroom setting, with system and component documentation, and suitable classroom training aids.

B. Training will be conducted by the Contractor and the equipment vendors.

C. Training for the Commissioning Team members on the Commissioning Plan will be provided by the CA. All Commissioning Team members are required to attend this training.

3.5 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 23, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. Red-line all drawings on two sets. Include architectural floor plans, elevations and details, and the individual mechanical or electrical systems in relation to actual building layout in Division 23 as-built drawings.

B. Maintain as-built red-lines as required by Division 1. Given the size and complexity of this project, red-line drawings at completion of construction, based on memory of key personnel, is not satisfactory. Continuous and regular red-lining of drawings is considered essential and mandatory. Maintain these drawings in the construction trailer and make them available for inspection at any time.

3.6 MISCELLANEOUS SUPPORT

A. Division 23 shall remove and replace covers of mechanical equipment, open access panels, etc., to permit Contractor, Contract Administrator, or CA to observe equipment and controllers provided.

END OF SECTION 23 0800

SECTION 23 2113 - HEATING HOT WATER SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Condition, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0505, Piping Specialties.

D. Section 23 0523, Valves.

E. Section 23 0700, HVAC Insulation.

F. **Division 25, Integrated Automation**, for temperature control valves, meters and instrumentation.

G. Division 26, Electrical.

PART 2 - PRODUCTS

2.1 PIPING

A. Hot water heating piping shall be black steel pipe A53 grade A or B, seamless ERW or BW, standard wall Schedule 40 through 10" diameter. Larger diameter pipe shall have wall thickness as follows:

Pipe Diameter, Inches	Wall Thickness, Inches
12" & larger	0.375

B. Contractor may use Type L hard drawn copper tubing, ASTM B88 for hot water piping sizes 2" and smaller. Proper insulating fittings, as specified in Section 23 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

A. Fittings for steel piping, 2" and smaller, shall be either screwed or welded. Screwed fittings shall be either Class 150, standard black malleable iron conforming to ANSI B16.3 or Class 125,

standard black cast iron conforming to ANSI B16.4. Weld fittings shall be either standard weight steel butt-welding fittings conforming to ANSI B16.9 or forged steel socket- welding fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.

B. Fittings for steel piping, 2-1/2" and larger shall be either standard weight steel butt-welding fittings, conforming to ANSI B16.9.

C. Fittings for copper piping shall be wrought copper conforming to ANSI B16.22, with 95-5 solder joints, as specified in Section 23 0504.

2.3 FLANGES

A. Flanges for steel piping system shall be forged steel, weld neck or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Where specifically required by the application, black cast iron Class 125, standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 VALVES

A. Valves other than automatic control valves are specified in Section 23 0523, HVAC Valves.

B. Automatic control valves shall be as specified in Division 25 Integrated Automation.

2.5 HOT WATER GENERATING EQUIPMENT

A. Hot water converters and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings.

2.6 PUMPS

A. Pumps shall be of the type and capacity listed in the Equipment Schedule. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping.

2.7 COILS

A. Hot water heating coils shall be as specified in Section 23 3000, and listed in the Mechanical Equipment Schedule.

2.8 WATER TREATMENT

A. Water treatment system, including shot type feeders shall be furnished by the Contractor.

B. Tanks shall be connected to the supply and return mains by means of 3/4" pipe with valves in each connection and with a 3/8" test cock on the supply connection. Tanks shall be wall or floor mounted on steel support adjacent to system pumps. The Contractor shall provide complete installation of water treatment equipment as shown on the drawings and as required by the Owner's designated Water Treatment Agency.

C. Chemicals as required for the system startup, operational testing and commissioning shall be provided by the Owner's designated Water Treatment Agency in sufficient quantities to maintain the level of chemical concentration recommended by the Water Treatment Agency and shall be included in the contract price. The exact type of chemical treatment compounds shall be determined by the Water Treatment Agency and approved by the Owner's Representative.

D. As a part of the contract price, the Contractor shall provide a one (1) year water treatment service contract by the Water Treatment Agency. Service contract shall include onsite testing on not less than a monthly basis and all required chemicals during the one (1) year project warranty period.

E. After system acceptance by the Owner, the continuing water treatment will be the Owner's responsibility.

2.9 FLOW MEASURING STATIONS

A. Furnish and install water flow measuring station and automatic flow control valves where shown on the drawings and as specified in Section 23 0505.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 23 0500, Common Work Requirements for HVAC, Section 23 0504, Pipe and Pipe Fittings. Installation of specialties shall conform to the requirements of Section 23 0505, Piping Specialties.

3.2 CLEANING AND FLUSHING PIPING SYSTEMS

A. New heating water piping systems installed under this Contract shall be chemically cleaned of oils, greases, dirt and mill scale. The new piping system shall be inspected by the Owner's approved Water Treatment Agency to determine the appropriate cleanout procedures and recommended cleaning chemical materials.

B. Cleaning shall be performed in strict accordance with the chemical treatment agency and manufacturer's recommendations, and shall generally consist of the following:

1. Fill, flush, and drain piping systems with water to remove loose dirt and debris from the system.
2. Refill piping system with cleaning compounds, diluted to recommended concentrations and circulate for required time period.
3. Drain and flush system.
4. Neutralize using caustic and soda ash as required when cleaning with acid compounds.
5. Drain and inspect system and repeat cleaning if necessary.

C. In conjunction with piping system cleaning, clean and inspect all strainers and suction diffusers. Remove, bypass, or otherwise protect as necessary all piping system components which may be damaged due to chemical cleaning, including filters, instrumentation gauges, flow meters, etc.

D. After completion of chemical cleaning and flushing, the piping system shall be immediately refilled and maintained with treated water. Under no circumstances shall cleaned piping be allowed to sit empty or filled with untreated water.

3.3 TESTS

A. All piping shall be proven tight at a hydrostatic pressure of 150% of the system design operating pressure, but not less than 125 PSI. The system shall show no loss in pressure or indication of leakage at any joint or connection for a period of one (1) hour.

END OF SECTION 23 2113

SECTION 23 2114 - CHILLED WATER SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0505, Piping Specialties.

D. Section 23 0523, Valves.

E. Section 23 0700, HVAC Insulation.

F. Division 25, Integrated Automation, for temperature control valves, meters and instrumentation.

G. Division 26, Electrical.

PART 2 - PRODUCTS

2.1 PIPING

A. Chilled water piping shall be black steel pipe ASTM A120 or A53 grade A or B, ERW or BW, standard wall Schedule 40 through 10" diameter. Larger diameter pipe shall have wall thickness as follows:

Pipe Diameter, Inches	Wall Thickness, Inches
12" & larger	0.375

B. Contractor may use Type L hard drawn copper tubing, ASTM B88 for chilled water piping sizes 2" and smaller. Proper insulating fittings, as specified in Section 23 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

A. Fittings for steel piping, 2" and smaller, shall be either screwed or welded. Screwed fittings shall be either Class 150, standard black malleable iron conforming to ANSI B16.3 or Class 125, standard black cast iron conforming to ANSI B16.4. Weld fittings shall be either standard weight

steel butt-welding fittings conforming to ANSI B16.9 or forged steel socket-welding fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.

B. Fittings for steel piping, 2-1/2" and larger shall be either standard weight steel butt-welding fittings, conforming to ANSI B16.9 as specified in Section 23 0504.

C. Fittings for copper piping shall be wrought copper conforming to ANSI B16.22, with 95-5 solder joints, as specified in Section 23 0504.

2.3 FLANGES

A. Flanges for steel piping system shall be forged steel, weld neck or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Where specifically required by the application, black cast iron Class 125, standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 VALVES

A. Valves other than automatic control valves shall be specified in Section 23 0523, Valves.

B. Automatic control valves shall be as specified in Division 25, Integrated Automation.

2.5 PUMPS

A. Pumps shall be of the type and capacity listed in the Equipment Schedule, and shall be furnished with drip-proof motors. Pumps shall be selected so that the motors will not overload under any operating conditions. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this contract. All pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping.

2.6 COILS

A. Chilled water coils shall be as specified in Section 23 0505 and as listed on the Mechanical Equipment Schedule.

2.7 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15-1994. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

2.8 WATER TREATMENT

A. Water treatment system, including shot type feeders shall be furnished by the Contractor.

B. Tanks shall be connected to the supply and return mains by means of 3/4" pipe with valves in each connection and with a 3/8" test cock on the supply connection. Tanks shall be wall or floor mounted on steel support adjacent to system pumps. The Contractor shall provide complete installation of water treatment equipment as shown on the drawings and as required by the Owner's designated Water Treatment Agency.

C. Chemicals as required for the system startup, operational testing and commissioning shall be provided by the Owner's designated Water Treatment Agency in sufficient quantities to maintain the level of chemical concentration recommended by the Water Treatment Agency and shall be included in the contract price. The exact type of chemical treatment compounds shall be determined by the Water Treatment Agency and approved by the Owner's Representative.

D. As a part of the contract price, the Contractor shall provide a one (1) year water treatment service contract by the Water Treatment Agency. Service contract shall include onsite testing on not less than a monthly basis and all required chemicals during the one (1) year project warranty period.

E. After system acceptance by the Owner, the continuing water treatment will be the Owner's Responsibility.

2.9 FLOW MEASURING STATIONS

A. Furnish and install where shown on the drawings and as specified in Section 23 0505, water flow measuring stations and automatic flow control valves.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 23 0500, Common Work Requirements for HVAC, and Section 23 0504, Pipe and Pipe Fittings. Installation of specialties shall conform to the requirements of Section 23 0505, Piping Specialties.

3.2 CLEANING AND FLUSHING PIPING SYSTEMS

A. New chilled water piping systems installed under this Contract shall be chemically cleaned of oils, greases, dirt and mill scale. The new piping system shall be inspected by the Owner's approved Water Treatment Agency to determine the appropriate cleanout procedures and recommended cleaning chemical materials.

B. Cleaning shall be performed in strict accordance with the chemical treatment agency and manufacturer's recommendations, and shall generally consist of the following:

1. Fill, flush, and drain piping systems with water to remove loose dirt and debris from the system.
2. Refill piping system with cleaning compounds, diluted to recommended concentrations and circulate for required time period.
3. Drain and flush system.
4. Neutralize using caustic and soda ash as required when cleaning with acid compounds.
5. Drain and inspect system and repeat cleaning if necessary.

C. In conjunction with piping system cleaning, clean and inspect all strainers and suction diffusers. Remove, bypass, or otherwise protect as necessary all piping system components which may be damaged due to chemical cleaning, including filters, instrumentation gauges, flow meters, etc.

D. After completion of chemical cleaning and flushing, the piping system shall be immediately refilled and maintained with treated water. Under no circumstances shall cleaned piping be allowed to sit empty or filled with untreated water.

3.3 TESTS

A. All piping shall be proven tight at a hydrostatic pressure of 150% of the system design operating pressure, but not less than 125 PSI. The system shall show no loss in pressure or indication of leakage at any joint or connection for a period of one hour.

END OF SECTION 23 2114

SECTION 23 2123 – PUMPS

PART 1 - GENERAL

1.1 SCOPE OF SERVICES

A. Supply pumps as specified herein, including freight to job site. Coordinate with Contractor for delivery and proper installation. Align pumps, instruct Owner's operating personnel in proper operation and maintenance, and provide two sets of O&M Manuals.

1.2 WARRANTY

A. Provide parts and labor warranty for 18 months from shipment, 12 months from beneficial use. Warranty service must be guaranteed within four hours of notice, 24 hours per day, and 365 days per year.

1.3 SUBMITTALS

A. Five sets within one week after award: Full shop drawings for pumps and motors including assembly drawings; materials of construction; seal; motor HP, insulation, manufacturer, and full load motor efficiency; coupling; pump curve; and NPSH required.

PART 2 - PRODUCTS

2.1 PUMPS

A. General:

1. Factory assembled packaged pump and motor of bronze-fitted, cast iron construction, single-state, suitable for scheduled conditions of service. Entire assembly shall be finished with a suitable coating for long-term corrosion resistance.
2. General: Pump and motor mounted on steel or cast iron baseplate suitable for grouting in place, with raised lip drip pan and tapped drain connection. Coordinate rotation with piping and equipment layout.
3. Pump and motor capacities and efficiencies: Pump capacities shall be a minimum as scheduled, and suitable for parallel operation. Motors shall not exceed HP listed. Unit shall operate over the entire pump curve without exceeding the motor nameplate rating. Supplier may deviate from the pump and motor efficiencies listed as long as the total electric power required to drive all pumps does not exceed the total power per the schedules, and as long as no motors change in size.
4. Pump characteristics: Curve shall rise continuously from maximum capacity to shutoff, operation at or near peak efficiency, capable of operating over entire flow range listed at full speed without exceeding break-off point or exceeding manufacturer's recommendations. Impeller diameter shall not exceed manufacturer's minimum published diameter plus 90 percent of the difference between published maximum and

5. Minimum impeller diameters.
6. Casing: close grain cast iron, 175 psig rated, with 125 psi ASA flanges, plugged drain and vent connections, and replaceable bronze wearing rings.
7. Impeller: Centrifugal type, total enclosed, non-overloading, one-piece bronze impeller, with entire rotating assembly statically, dynamically and hydraulically balanced.
8. Shaft: Carbon steel, minimum AISI C1045.
9. Motor: Squirrel cage induction type, 1.15 service factor, Class B insulation, and premium efficiency per IEEE Standard 112, Test Method B, 460/3/60, non-overlooking and suitable for continuous operation at any point along the pump curve.
10. Bearings: Grease lubricated, moisture and dust resistant housing, minimum 20,000 hour B-10 life (100,000 hour average life) under scheduled conditions of service.
11. Coupling: Flexible type with removable guard, similar to Waldon, Thomas, Falk, Fast or Woods.

B. Horizontal Split Case Type: Double suction type, ODP motor, and 316 stainless steel shaft sleeve.

1. Mechanical seals: Single, unbalanced, inside mounted, end face rubber bellows type with stainless steel spring, brass or stainless steel seal heads, carbon-graphite rotating washer, and renewable tungsten-carbide stationery seat, similar to John Crane Type 1. Supply one spare seal of each size. Aurora Type 410.

2.2 APPROVED MANUFACTURERS

Armstrong
Aurora
Peerless
Worthington-Dresser
Goulds
Weinman
Crane Deming
Bell & Gossett

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate rotation with drawings.

B. Prior to shipment clean flanges and exposed machined metal surfaces and treat with anti-corrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Provide pump foundations as indicated on drawings. Install pumps on foundations. Affix to base using either anchor bolts or expansion anchors.

D. Provide piping, valves, strainers, and instrumentation as indicated.

E. Align pumps per manufacturer’s recommendations, but not less than within 0.002 inches. Grout pumps into place after alignment using non-shrink grout.

F. For pumps with variable speed drives provide a technician to set up drive as specified herein. Demonstrate proper system operation.

G. Supplier shall submit a written report stating that pumps are properly installed, aligned and operating.

H. Provide minimum two 2-hour training sessions for Operating Personnel.

END OF SECTION 23 2123

SECTION 23 2313 - REFRIGERANT PIPING SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform to the applicable provisions of the General Conditions, the Supplemental General Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0505, Piping Specialties.

D. Section 23 0523, Valves.

E. Section 23 0700, HVAC Insulation.

F. Division 25, Integrated Automation, for temperature control valves, meters and instrumentation.

G. Division 26, Electrical.

H. Refrigerant piping, insulation, and accessories associated with medical equipment and kitchen equipment furnished under other sections of this specification shall be furnished and installed by the equipment sub-contractors and is not a part of Division 23.

1.3 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere.

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS & FAN COIL UNITS

A. Air Handling Units and Fan Coil Units shall be as specified on the Equipment Schedule on the drawings and Section 23 3000.

2.2 AIR HANDLING UNITS

A. Air handling units with dual refrigeration system, consisting of chilled water and direct expansion refrigeration and with remote roof mounted air cooled condenser shall be furnished as specified in Section 23 3000 and on the Equipment Schedule on the drawings.

B. Chilled water cooling shall be in accordance with requirements in Section 23 2114.

2.3 PIPING

A. Refrigerant piping materials and installation shall be in accordance with the best working and piping practices for Freon refrigerants. The Contractor shall install the refrigerant piping using Type "L" hard drawn copper tubing, Federal Specification WW-T-749, with silver solder joint. All piping shall be installed in a straight manner, free from traps, and shall be provided with plugged or capped ends, as it is erected, to prevent dirt from entering. The piping system shall be provided with gauges as required for the operation of the system. The piping is shown schematically on the drawings, verify exact arrangement and pipe sizing with equipment manufacturer.

2.4 VALVES

A. Expansion valves shall be of the thermostatic type as manufactured by Alco, Sporlan, or equivalent, and shall be gas charged with capillary tube, external superheat adjustment and external equalizing connection. The expansion valves at each apparatus shall be protected by a strainer in the refrigerant liquid line to that group. The strainer shall be as manufactured by the Henry Valve Company, or equivalent, not less than line size and provided with shut-off valves before and after, and furnished with the packaged reciprocating unit.

B. Solenoid valves shall be suitable for the system in which they are used and shall be designed specifically for use with Freon refrigerants. Solenoid valves shall be furnished with the packaged reciprocating unit.

C. Refrigerant line valves shall be packless type or packed type with gas tight cap seal with wheel, globe, angle, or "T" needle type, with hard metal seats and shoulders on stems to permit packing stuffing boxes while open under pressure, or sealed diaphragm type.

2.5 DRYER

A. In each liquid line, install a suitable silica gel filter and dryer. Dryer shall be furnished with the chiller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 23 0500, Common Requirements for HVAC, and Section 23 0504, Pipe and Pipe Fittings.

3.2 TESTING OF REFRIGERANT PIPING SYSTEM

A. After the installation of the refrigerant piping system has been completed, all piping shall be tested and proven tight for a period of twenty four hours at a pressure of 150 lbs. per square inch using dry nitrogen.

3.3 EVACUATION AND CHARGING

A. Upon completion of the piping pressure test, the refrigerant circuit shall be evacuated to 500 microns using a closed tube manometer and a high vacuum pump (using an electronic vacuum gauge that reads in microns) to ensure tightness of the piping and to remove air and moisture from the piping system. Upon completion of evacuation and acceptance of the system tightness, the vacuum shall be broken by the introduction of the refrigerant.

3.4 REFRIGERANT AND LUBRICATING OIL

A. Contractor shall furnish and install all of the refrigerant required to develop the system to its full rating, and in addition to the initial charge, the Contractor shall be required to provide all refrigerant required for the proper operation of the refrigeration apparatus during the first season's operation. Contractor shall guarantee that the loss of refrigerant for a season’s operation shall not exceed 10% of the full charge of the system and he shall furnish any refrigerant required above this amount. This guarantee shall remain in effect until such time as the Contractor shall demonstrate this performance for one full year's operation. The Contractor shall be required to provide the initial charge of lubricating oil for all refrigeration apparatus and related equipment, and shall furnish a chart listing the type of oil and a schedule for maintenance that should be used with the various equipment.

3.5 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15-1994. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

END OF SECTION 23 2313

SECTION 23 3000 – AIR TEMPERING SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Provide all products, labor and services necessary to construct and demonstrate proper functionality of the HVAC and exhaust systems indicated on the drawings and specified herein.

B. Conform with applicable provisions of the General Conditions, the Supplemental General Conditions and General Requirements.

C. See Sections 23 0500, 23 0548, 23 0549, 23 0593, 23 0700, and 23 0900 for additional requirements.

D. Comply with the Equipment General Requirements in Spec Section 23 0500.

1.2 SCOPE

A. Install control dampers supplied under Section 23 0900. Adjust dampers for smooth operation.

B. Equipment provided by others: Provide ductwork to serve equipment provided by others, including fume hoods, etc., where that equipment requires ducted supply or exhaust.

1.3 SUBMITTALS

A. Submit the following for review and approval:

1. All equipment shown on the equipment schedule and elsewhere on the drawings. Submit evidence or certification that equipment complies with ASHRAE Std. 90.1.
2. Ductwork construction standards, sheet metal, plenums, ductwork accessories, etc.
3. Flues and vents: Materials of construction and accessories. For vents with horizontal offsets or expansion joints, submit layout for review.
4. Dampers for fire and smoke control: For each type of damper proposed, submit manufacturer's literature demonstrating compliance with all aspects of the specifications and drawings. Submit manufacturer's installation instructions.
5. Air Filters and Filter Gauges
6. Grilles, Registers & Diffusers: Configuration, materials of construction, finish, mounting details, and performance data including throw, static-pressure drop, and noise ratings. Submit for type only, but supplier shall check and verify that the indicated diffuser type and sizing are appropriate for each area. Advise of any concerns in any areas.
7. Terminal Units:

    a. Submit the following for each type of unit: Unit construction, materials, and wiring diagrams.
    b. Submit the following for each size unit: Dimensional data, recommended flow ranges, and performance data (pressure drop and sound data) at maximum flow.

c. Submit a schedule showing the following for each terminal unit indicated on the drawings: Tag number, max & min CFM, size, pressure drop, and heating system performance.

8. Layouts of systems covered by this section of the specifications. Layouts shall be at a scale appropriate for the areas shown. Include large scale sections as appropriate.

1.4 QUALITY ASSURANCE

A. Comply with the following codes & standards:

1. UMC 2006 Chapter 6 – Duct Systems
2. UMC 2006 Standard 6-2, Standard for Metal Ducts
3. SMACNA 2005 HVAC Duct Construction Standards – Metal and Flexible, including Addendums
4. SMACNA Round Industrial Duct Construction Standards – 1999
5. SMACNA Rectangular Industrial Duct Construction Standards – 2004
6. NFPA-90A-2002 - Standard for the Installation of Air-Conditioning and Ventilating Systems

B. Component Characteristics

1. All components within ducts and plenums shall be non-combustible or shall have a flame spread less than 25 and smoke developed less than 50 when tested as a composite product per NFPA 255, ASTM E84, or UL 723, except where specifically permitted by the UMC and noted in the drawings or specs.

1.5 SOUND LEVELS

A. Sound levels attributable to mechanical equipment are designed to result in sound levels of NC 40 for offices, conference rooms, and NC 35 for classrooms, etc., measured within the rooms. Mechanical equipment that has been substituted for the specified equipment shall perform within the specified equipment sound limitations, or will be replaced or adjusted as required. Sound levels attributable to duct vibration that result in noticeable noise or vibration to duct hangers, lighting fixtures, ceiling tees or diffusers shall be re-supported or adjusted until the disturbing noise is brought within acceptable limits.

1.6 DIMENSIONS

A. Compare all drawings and verify all dimensions both on the drawings and in the field before laying-out, cutting, and fabricating the work.

B. Refer to Section 23 0500, Common Work Requirements for HVAC, for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 DUCTWORK AND PLENUMS

A. Materials: Construct all ducts, casings, plenums etc. from galvanized steel sheets except as indicated. Sheets shall be free of blisters, slivers, pits, and imperfectly galvanized spots. Reinforcing angles and bars, and duct support materials shall be same material as ductwork if exposed to the air stream, or galvanized steel if not exposed to the air stream.

1. Galvanized Steel: Per ASTM A653/A653-03 Standard Specification for Steel Sheet, Zinc-Coat (Galvanized) or Zinc-Iron Alloy-Coat (Galvanized) by the Hot Dip Process, with minimum 1.25oz/sf zinc.
2. Aluminum: Alloy 3003-H14
3. Stainless Steel: 340SS, provide No. 2B finish in exposed areas
4. Fiberglass Ductwork (Ductboard): Use only where specifically noted. Minimum 1-inch thick, 3 lb. density rigid fiberglass ductboard with glass fiber reinforced vapor barrier, UL Class 1, labeled on each board per UMC-06 Standard 6-5.

    a. Properties:

        1) Thermal conductivity for 1-inch thickness shall not exceed 0.22 Btuh/SF-F at 75 deg F
        2) Noise reduction coefficient of 0.80 on Mounting No. 6.

    b. Tape: 3-inch "Hardcast" mineral impregnated woven fiber tape with an actuator/adhesive applied in accordance with the manufacturer's directions, or thermlok heat sensitive tapes. Pressure sensitive tapes will not be accepted.
    c. Owens-Corning Fiberglass, Johns Manville, Certain-Teed or equivalent. Flexural rigidity (E.I.) average shall not be less than 475.

5. Polyvinyl Coated Galvanized Steel: Minimum 4 mil polyvinyl coating. Foremost Manufacturing Company, Southfield, Michigan. Model PCD 4 by 1 for exterior coating only, or Model PCD 4 by 4 for both interior and exterior coating.

B. Double-Wall Round, Rectangular, and Oval Ducts and Fittings.

1. Provide Double Wall Ducts as noted on the plans: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.
2. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
3. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC

Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.

5. Inner Duct: Minimum 24-gauge solid galvanized sheet steel.

C. Flexible Ducts: Factory fabricated, listed as a Class 1 Air Duct per UL 181, corrosion resistant helix mechanically locked to fabric to ensure dimensional stability, helix separated from air stream, R-5 fiberglass insulation, and metalized outer vapor barrier. Ducts shall be rated at 10-inch positive pressure, 5-inch negative pressure, 0.1 perm per ASTM E96, and -20 to +250oF. Flexmaster Type 3M, Thermaflex M-KC, OAE.

1. Flexible duct runs shall be limited to 6 feet. Flexible ducts shall be factory insulated and comply with the latest NFPA 90A & 90B. Flexible duct connections shall be made using stainless steel draw bands. Flexible ducts shall not be used in exhaust, return or other negative pressure duct system due to risk of collapse or excess of airflow.

D. Ductwork Accessories

1. Sealers: Water based, for use on galvanized steel and with the other materials specified herein, suitable for use at -20 to +200oF and duct pressures to 10 inches wg, dry to the touch within 12 hours, sufficiently flexible to pass a 0.25-inch mandrel test, listed per UL-181A & 181B, and suitable for storage and application at 40–110oF. Approved Manufacturers: Carlisle Coatings & Waterproofing “Hardcast,” Foster, RCD, AM Conservation Group, OAE.
2. Tapes: 4” woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal. Water, mold, and mildew resistant for indoor and outdoor service. Sealant shall be modified styrene acrylic.

2.2 SHEET METAL ACCESSORIES

A. Dampers: Factory fabricated, suitable for use with air at -20 to +240oF, galvanized steel housing and blades except as noted, rated for indicated pressures in either direction and performance rated per AMCA-500.

1. Shafts: Square or hexagonal steel, 3/8-inch or 1/2-inch, continuous through damper, mechanically fastened to damper blade, and extending through frame as required for actuator or standoff bracket and locking quadrant as required by table below.
2. Bearings: Provide for each side of each shaft, molded synthetic or stainless steel sleeve type.
3. Multi-blade dampers: Except as indicated, provide parallel-blade for 2-position applications and opposed blade for modulating applications. Provide jackshafts as required to drive large dampers.
4. Air pressure drop shall not exceed:

   a. Dampers rated at 1500 FPM: in wg at 1500 FPM
   b. Dampers rated at 4000 FPM: in. wg at 4000 FPM

5. The dampers described in this section are assigned Type Numbers D1 through D23. The following table summarizes key characteristics of each type of damper. Drawings and Part 3 – Execution, indicate which type of damper to use in each application.

Type	Shape	Blade	Max Size (inches)	Multiple Sections	Rated Velocity (FPM)	Rated Shutoff Press. (in. wg)	Seals	Leakage (CFM/SF @ 1 in. DP)	Notes	Ruskin Model
D1	Rect	Flat	36 x 12	No	1500	2.5	No	--	1	MD15
D1	Rect	3V	48 x 48	No	1500	2.5	No	--	1	MD15
D2	Rect	Flat	36 x 12	No	1500	2	No	--	1	MD25
D3	Rect	3V	48 x 48	Yes	1500	2	No	80	1	MD35
D4	Rect	3V	48 x 72	Yes	1500	2.5	No	40		CD35
D5	Rect	3V	48 x 72	Yes	1500	2.5	Yes	4		CD36
D6	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2	2	CD50
D7	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2		CD60
D20	Round	Flat	20	No	1500	2	No	40	1	MDSR25
D21	Round	Double	40	No	4000	10	Yes	4		CDR25
D22	Round	Double	24	No	4000	6	Yes	6		CDSR25
D23	Oval	Double	72 x 24	No	4000	10	Yes	4		CDO25

Note 1: Provide locking hand quadrant and 2-inch standoff bracket
Note 2: Aluminum Construction

B. Flexible Connectors: Except as noted flexible connectors shall be heavy fiberglass cloth; coated to be air tight, water tight, fire retardant; suitable for temperatures of -20 to +200o F; rated for 10 in. wg positive or negative; with tensile strength minimum 450 lb/inch in the warp and 340 lb/inch in the filling. Provide flexible connectors in 3-3-3 configuration, with 3-inch galvanized steel strip along each edge and 3-inches of flexible fabric in the center.

1. Standard Applications: Flame spread 20, smoke developed 40, Ventfabrics Ventglas OAE
2. Applications Exposed to Sun and Weather: Double coated with du Pont Hyphalon, Ventfabrics Ventlon OAE.
3. Applications from 200 – 500o F: Tensile Strength 285 lb/inch in the wrap and 185 lb/inch in the filling. Ventfabrics Ventsil OAE
4. Corrosive Applications: Teflon coated, Ventfabrics Ventel OAE.

C. Duct and Plenum Access Doors: Galvanized steel, gasketed. Size as required to properly inspect and service components located within the ductwork. Ruskin, Acudoor, Ductmate, OAE.

1. Rectangular ducts up to 2-inch positive or negative SP: Minimum 22 gauge frame and door thru 12-inch size, 20 gauge door for larger sizes, double gasketed (between door and frame, and between frame and duct) with cam locks, either hinged or removable. Ruskin ADH22, ADC22, ADHW22, or ADCW22, Ventfabrics, OAE
2. Round or Rectangular Ducts to 12-inch Positive Pressure: Removable oval sandwich style with gasketed inner door, insulated outer door, and large hand knobs. Ruskin ADR and ADF.
3. Ducts to 12-inch Negative Pressure: Ruskin ADHP-3.
4. Plenum Access Doors: Factory fabricated frame and door rated to 4-inch positive or 8- inch negative pressure. Provide mill finish and neoprene seals to limit leakage to less than 0.1 CFM/inch perimeter with door closed. Doors shall open against air pressure.

    a. Frame: Extruded aluminum with 1.5-inch flange and mitered corners

b. Door: Extruded aluminum mitered frame, double wall 24-gauge galvanized steel panel with minimum R-5 insulation isolated from the air stream, full-length piano hinge and two heavy-duty latches similar to Ventlok 310.
c. Approved Manufacturers: Ruskin GPAD or approved equal.

D. Turning Vanes:

1. Single wall: Per SMACNA HVAC Duct Construction Standards Figure 2-3 & 2-4.
2. Double wall: Airfoil shape with smoothly rounded entry nose and extended trailing edge, minimum 2” x 3” vane crossection, hot dipped galvanized steel, 26-gauge vanes, 24- gauge runner, each vane double pinned to each runner, field adjustable to required elbow aspect ratio. Performance shall not exceed the following for a 24 x 24 elbow at 2000 FPM average: Air pressure drop 0.105 in. wg; aound generated 54 dB re 10^-12 watts. Aero/Dyne Co. Model HEP, Airsan, Elgen, or equivalent.

E. Roof Curbs and Equipment Support Rails: Factory fabricated, minimum 14-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction.

1. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, OAE.
2. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck OAE

F. Louvers: 4-inch extruded 6063-T5 aluminum alloy frame and blades with flange, mill finish, and 1/2-inch galvanized steel bird screen.

1. Structural: Designed and furnished to carry wind load of not less than 20 psf. Intermediate mullions and supports if provided as part of louver, shall not be visible from the exterior.
2. Air Pressure Drop: Less than 0.20 in wg at 1000 FPM over free area (8.58 square feet), intake or exhaust per AMCA 500 based on 48 x 48 test sample.
3. Moisture Penetration: Less than 0.01 oz/sf over 15 minute test per AMCA-500 at 873 FPM intake over free area based on 48 x 48 test sample.
4. Ruskin ELF375DX OAE.

G. Acoustic Louvers

1. Ruskin ACL 1245, 12 inches deep, with 45 degree blade angle, 22 percent free area (48" x 48" typical unit with .15 inch w.g. maximum pressure drop, at 4277 cfm air flow). Frame and blade material shall be galvanized steel. Free field noise reduction shall be:

Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Reduction (db)	14	13	15	20	23	22	20	20

2. Provide bird-screen, steel channel frame, Ruskatherm blanket insulation, and perforated steel interior surface that covers insulation.

H. Thermometers: As specified in Section 23 0505.

I. Barometric Pressure Balance Dampers: Air Balance, Inc. units with adjustable counter weight, aluminum air foil design blades, nylon bearings. Match frame assembly to wall or duct.

2.3 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT

A. General: Factory-built metallic vent system, UL Listed components. Each component shall bear indication of its UL listing.

1. Heat Resistant Paint: Glidden, Metallite OAE.
2. Approved Vent Manufacturers: Metal Fab, Metalbestos, Schebler, Ampco, OAE.

B. Type B Vent: Listed per UL 441 for use with UL Listed Category I (gas or propane fired, negative pressure, non-condensing) appliances to 530o F, round or flat oval as indicated, double wall with aluminum alloy inner wall, galvanized steel outer wall, both walls hemmed to eliminate sharp edges, minimum 1/4-inch air space for sizes 6-inches and smaller and minimum 1/2-inch air space for sizes 7-inches and larger, with guides to maintain air space. Provide UL Listed vent cap. Metal Fab Type M.

1. Barometric Draft Regulator: UL Listed, double acting type.

C. Type III Vent: For use with Category III appliances or other positive pressure, non-condensing appliances including oil-fired or solid-fuel equipment not exceeding 1200o F exhaust temperature. Listed per UL-103 for use with gas, liquid or solid fuels per NFPA-211 which produce gases up to 1400o F continuously and 1800oF intermittently. Double wall with spacers to maintain alignment, rated for 10-inch clearance to combustibles, 4-inch clearance to noncombustibles, and zero clearance to fire-rated or non-combustible chase.

1. Inner Pipe: Connected with V-bands of same material as inner pipe, and sealed with silicone sealant appropriate for the exhaust gas temperature. Pressure tight to 60 inches water.
2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors.
3. Expansion Joints: Bellows type.
4. Options and Accessories:

    a. Inner Wall: 304 SS.
    b. Outer Wall: Aluminized steel.
    c. 12-year warranty against defects in materials and workmanship

D. Type IV Vent: For use with Category II or Category IV appliances (natural gas or propane- fired, positive or negative pressure, condensing, not exceeding 550o F exhaust temperature). Listed per UL-1738, double wall with 1-inch clearance and spacers to maintain alignment.

1. Inner Pipe: AL2904C superferritic SS manufactured by Allegheny Ludlun, with welded seams, connected with V-bands, and sealed with high temperature silicone sealant. Rated at 6 inches water. Thickness: 0.015-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors. Thickness: 0.018-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
3. Options and Accessories:

    a. Outer Wall: Aluminized steel

4. Metal Fab Type CG

2.4 DAMPERS FOR FIRE AND SMOKE CONTROL

A. General: Factory assembled and UL listed as an assembly, suitable for horizontal or vertical air flow and for ducted or un-ducted applications. Fire dampers (FDs) shall be listed per UL 555, smoke dampers (SMDs) shall be listed per UL 555S, and fire/smoke dampers (FSDs) shall be listed per UL 555 and UL 555S. Units shall be galvanized steel except as noted. Approved manufacturers: Greenheck, Ruskin, Potorff, or approved equal.

B. Combination Fire/Smoke Dampers: Factory assembled complete with damper, actuator, thermal link, and all specified accessories, all mounted on a sleeve.

1. Construction: Round blades, rectangular parallel blades and rectangular opposed blades are acceptable, except dampers shall be rectangular opposed blade type when installed in any of the following conditions: within 10 diameters of a fan or supply register, within 3 diameters of an elbow. Internal frames in rectangular FSDs shall be low profile type for ducts 17”H and less.
2. All components factory installed and wired, including actuator, thermal link, position switches, temperature over-ride (if specified), test switch (if specified), etc. Mount all such components on outside of FSD sleeve to the side of duct (not top or bottom) except where indicated or approved. FSDs must be suitable for rotating the unit 180-degrees so these components can be on either side of the duct.
3. Air pressure drops shall be certified per AMCA 500D. Pressure loss coefficient Co shall not exceed the following when tested per AMCA Figure 5.3:

Size (in)	3-V Blade	Airfoil Blade	Round
12 x 12	2.41	2.01	NA
24 x 24	0.65	0.60	NA
36 x 36	0.44	0.27	NA
12 x 48	0.76	0.91	NA
12 Round	NA	NA	0.33
24 Round	NA	NA	0.23

4. Listed for installation within wall, floor or ceiling assemblies as indicated on drawings.

   a. Ratings, except as noted: 1.5-hr Fire Rated, Leakage Class 1, 350oF, 4-inch StaticPressure, Dynamic.

      1) Up to 1600 FPM: Greenheck FSD-211 (3-V blade type), OFSD-211, or FSDR-511 (round).
      2) Up to 3000 FPM: Greenheck FSD-311 or 311V (airfoil blade) or OFSD- 311.

   b. 3-Hr Rated Walls: Greenheck FSD-231.
   c. Stainless Steel: Greenheck SSFSD-211 or SSFSDR-511 (round).

5. Actuators: Electric 2-position, 115/1/60 (provide factory wired transformer if required), normally closed, spring return, NEMA-1 except as noted. Actuator shall fully re-open damper when power is restored after any power interruption.

6. Accessories

    a. Transitions: Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate for the application.
    b. Thermal Link: Provide re-settable bi-metallic thermal link to initiate closure when the air temperature within the duct rises to 165o F. Where indicated provide thermal links for operation at 212o F, 250o F, or 350o F. Thermal link shall be easily resettable from outside the duct.
    c. Position Switches: Provide dry contacts for remote monitoring of damper open and closed positions.
    d. Retaining plates and angles: Provide as required. Galvanized steel specifically designed for the particular FSD and included as part of the UL Listed assembly.
    e. Installation decals: Provide installation decals on the sleeve which give the installer clear installation instructions.
    f. Temperature Override Control: Provide controls so that the thermal link can be over-ridden and the FSD opened for smoke control, even if the air temperature exceeds the setting of the thermal link, provided the temperature does not exceed 350o F.

C. Smoke dampers: Similar to fire/smoke dampers noted above, except as follows:

1. Smoke dampers shall comply with UL 555S, but need not comply with UL 555.
2. Smoke dampers need not have a fire rating.
3. The thermal link and temperature override are not applicable.
4. Suitable for installation within a wall, floor or ceiling assemblies as indicated.

    a. Ratings, except as noted: Leakage Class 1, 350o F, 4-inch Static Pressure, Dynamic.

        1) Up to 1600 FPM: Greenheck SMD-201 (3-V blade type) or SMDR-501 (round).
        2) Up to 3000 FPM: Greenheck SMD-301, 301V (airfoil blade) or SMDR-401.

    b. 6-inch pressure rated: Similar to Greenheck SMD-401
    c. Stainless Steel: SSSMD-201 & SSSMDR-501 (round).

D. Fire Dampers: Dynamic rated, suitable for closing against 8-inch differential pressure. Curtain type with sleeve and 165oF replaceable fusible link, resettable. Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate.

1. 1.5-hr rated: Greenheck DFD-155
2. 3-hr Rated: Greenheck DFD-355.
3. Provide 212o F fusible links for high temperature applications.

E. Ceiling Radiation Dampers: UL Classified for use with fire rated floor/ceiling assemblies, with 165oF fusible link replaceable through the damper assembly, 1.5-hr rated except as noted. Greenheck CRD-1, CRD-2 (round), CRD-60, or CRD-60X. Provide 212o F fusible link and 3- hr rated dampers where indicated.

2.5 FILTERS AND FILTER GAUGES

A. Rated per ASHRAE Std. 52.1; Class 1 or 2 per UL Std. 900; glass fiber media; suitable for operation from -20o F to +170o F; corrosion resistant; suitable for installation with pleats either horizontal or vertical, and for air flow horizontal, vertical upflow, or vertical downflow; suitable for face velocity up to 625 FPM. Unless specified elsewhere, pre-filters shall be MERV-7, and final filters (where specified) shall be MERV-14. AAF, Camfil Farr, or approved equal.

		MERV RATING						
		7	11	14	11	14	11	14
Description							High Capacity	
Configuration		2-inch or 4-inch	12-inch Cartridge		6-inch Cartridge		12-inch Cartridge	
Initial Resistance	in. wg.	0.26	0.25	0.58	0.39	0.58	0.29	0.49
Rated Velocity	FPM	500	500	500	500	500	500	500
Max Velocity	FPM	625	625	625	625	625	750	750
Recommended Final Resistance	in. wg.	0.7	1.5	1.5	1.5	1.5	1.5	1.5
Gross Media per 24 x 24 Filter	SF	14 Pleats per foot	62	62	105	125	175	175
Housing		Cardboard	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel			
Frame		Channel	Gasketed		Gasketed		Gasketed	
AAF Model		Perfect Pleat	VariCel RF		VariCel M-Pak		VariCel V	
Camfil Farr Model		3030	RigaFlow					

B. Filter Gauges: Provide a filter gauge for each bank of filters. Gauges shall be magnehelic type with static pressure tips and inter-connecting piping. Ranges shall be 0-1 inch w.g. for all filters except bag filters which shall have a range of 0-2 inches w.g.

2.6 TERMINAL UNITS

A. General: Factory packaged unit with casing, air valve, air flow sensor. If the following sections are specified or required, provide them as part of the factory package: heating section, fan, and sound attenuator. Terminal units shall be suitable for variable volume operation over the scheduled air flow ranges. Air flow and sound performance shall be rated per ARI 880. All materials in the air stream shall comply with the requirements of UL-181 and NFPA- 90A.

1. Unit Construction:

a. Casing: Minimum 22-gauge galvanized steel with round inlet collar, rectangular outlet collar, 3/4-inch acoustic lining with cut edges coated with sealant.

1) [Hospital Applications: Provide aluminum foil liner over acoustic lining in casing and all accessory sections (e.g., sound attenuator). Liner shall comply with:

a) UL 181 – Air Erosion, Mold Growth & Humidity
2) UL 723 – 25/50 flame & smoke
3) ASTM E84 – 25/50 flame & smoke
4) ASTM C665 – Fungi Resistance]

b. Air Valve: Heavy gauge metal damper, shaft to extend through casing, self-lubricating bearing, with leakage not to exceed 2% of rated air flow when closed with 3-inch inlet pressure.
c. Air Flow Sensor: Cross configuration located at inlet of assembly, accurate to within 5% with 90° elbow directly at inlet connection. Provide
d. Sound Attenuator: Galvanized steel with acoustic lining. Provide aluminum liner if specified for casing.
e. Heating Section:

a. Heating Section:

1) HW Coils: Copper tubes, aluminum fins, galvanized steel casing, sweat connections, ARI rated, minimum 300 psi rated. Size heating coils for the capacities indicated on the equipment schedule. Provide single row coils wherever they can do the specified heating duty. Provide 2-row coils where indicated and where required for the indicated heating capacity. Do not exceed 0.5-inch static pressure drop for the entire unit (terminal unit, heating coil and sound attenuator). Where necessary to limit pressure drop, either over-size unit or provide a separate, larger (lower pressure drop) heating coil to be installed in the discharge ductwork.
2) Electric Heaters: Factory installed and wired with all necessary safety controls, UL listed as an assembly, with galvanized steel enclosure, 80/20 nickel chrome heater elements, electronic modulating control with 4-20 mA input signal from DDC system, air flow switch, access door with door interlock disconnect switch, automatic reset primary thermal cutout switch, manual reset secondary thermal cutout, 24-V control transformer, NEMA-1 enclosure for all electrical components with hinged access door with wiring diagram. Controller shall be solid state type to minimize electrical interference and for silent operation.

2. Sound Data: The equipment schedules show maximum allowable NC levels based on unit sound power measured per ARI-885, and sound attenuation per ARI-885 Appendix E with a Type 2 ceiling. Do not exceed the scheduled sound levels.
3. Controls: Controls will be supplied by the controls contractor for installation by terminal unit (TU) supplier. Coordinate with controls contractor who will ship controls to TU manufacturer. TU manufacturer shall install controls onto terminal units.
4. Approved Manufacturers: Price, Anemostat, Titus, Krueger, or approved equal.

B. VAV Reheat: Single duct type with reheat as indicated, Price SDV.

2.7 COILS

A. Galvanized steel casing, copper tubes and aluminum fins except as noted, with tubes mechanically expanded into fins, circuited to allow completely draining and venting coil, drain and vent connections, with performance rated per ARI. Do not exceed scheduled air or water pressure drops by more than 5 percent.

PART 3 - EXECUTION

3.1 DUCTWORK AND PLENUMS

A. Ductwork

1. Construct ductwork with wall thicknesses and reinforcing per the SMACNA HVAC Duct Construction Standards, Second Edition, 1995, and UMC 2006 Chapter 6,
2. Pressure Classes: Construct ductwork to the following pressure classes:

Duct Element Description	Relative Pressure	Pressure Class
From Outside Air Louver to Filter:	N	1"
From Air Handling Unit to Terminal Unit:	P	4"
From Single Zone AHU to Diffuser	P	2”
From Terminal Unit to Diffuser:	P	1"
From Return Grille to Fan:	N	1"
From Return Fan to Relief Louver:	P	1"
From Exhaust Register to Exhaust Fan:	N	2"

3. Minimum thickness for sheet metal ductwork: 26 gauge.
4. Sealing: Seal ductwork and plenums as follows:

	Seal Class			
	Supply Ducts			
Location	≤2 in. wg	≥2 in wg	Exhaust	Return
Outdoors	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces including RA Plenums	C	B	B	C

Seal Class	Description
A	All transverse joint, longitudinal seams and duct wall penetrations.
B	All transverse joints and longitudinal seams.
C	Transverse joints

a. Apply duct sealer to inside of seams and joints. Do not use pressure sensitive tape as the primary sealant.

5. Clearance to earth: Maintain minimum 4-inch separation between ductwork insulation and earth.
6. Openings in Ductwork: During installation protect the open ends of ducts to prevent debris and dirt from entering.
7. Provide turning vanes in square elbows of low velocity supply and exhaust ductwork.
8. Collars: Where exposed ducts pass through walls, floors, or ceilings, provide a tight- fitting, flanged sheetmetal collar around duct and tight against finished surface to cover opening and present a neat appearance. Lock collar to duct.
9. Cross Breaking: Cross-break low velocity rectangular sheetmetal ducts on all four sides. Cross break sheet metal between standing seams or reinforcing angles. The center of cross break shall be of the required height to assure surfaces being rigid. Do not cross- break high velocity plenum panels.

10. Grilles Registers and Diffusers: Install plumb, affix to general construction as appropriate, make air-tight connection to ductwork, and adjust air flow pattern to achieve appropriate velocities in the occupied zones. Request direction from Engineer if any question exists regarding proper air flow adjustment.
11. Duct Thermometers: Provide thermometers to indicate mixed air, outside air, and supply air of indoor air handling units over 2,500 cfm and where shown on the Drawings.
12. Test Holes: Provide test holes in ducts at locations where testing is required per Section 23 0593 and as requested by the T&B agent. Close test holes with rubber plugs. Reseal all insulated ductwork with the same insulation, jacket and vapor barrier material after T&B is complete.
13. Closure Systems:

    a. Rigid Air Ducts: Comply with UL 181A – Standard for Closure Systems for Use with Rigid Air Ducts and Air Connectors.
    b. Flexible Air Ducts: Comply with UL 181B – Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors.

14. Factory Made Air Ducts: Install in accordance with the terms of their listing and the manufacturer's recommendations.
15. Acoustic Insulation: See Section 23 0700, HVAC Insulation. Fabricate ductwork so the dimensions indicated on the drawings are the clear dimensions for air flow inside the acoustic insulation.
16. Coordination with Building Construction

    a. General: The drawings show the general intended configuration of the ductwork. Provide additional offsets where necessary to coordinate with the building construction or with the work of other disciplines. Transition ductwork as required at no change in contract price. Where this is necessary, submit for review and maintain the indicated flow areas.
    b. Ductwork is frequently routed through bar joists and between bar joists.
    c. Coordinate duct locations with joist submittals prior to fabrication.

B. Special Applications

1. Moisture Laden Ductwork: Stainless steel with all joints liquid-tight by continuous external welding. Welds shall be free from pits, runs, spatter and other imperfections. Pitch horizontal ductwork downward to intake opening. Where traps occur that collect water, provide a 1/2-inch half coupling welded to the bottom of the duct and pipe to spill over nearest drain. Include a properly sized trap in the drain piping.
2. Fume Hood Ductwork: Stainless steel with seams and joints continuously welded on the exterior. Spiral lock seam is not acceptable.
3. Shower Room Exhaust Ductwork: Aluminum
4. Ducts Handling Corrosive Vapors: Either stainless steel or galvanized steel with internal polyvinyl coating constructed and sealed as noted.
5. Underslab Ductwork: Galvanized steel, polyvinyl coated on the exterior, constructed and sealed for 2-inch SP, insulated per Section 23 0700, and concrete encased. Concrete thickness shall be as indicated on the drawings, but not less than 2-inch thick.

    a. Take care to prevent damaging ductwork when concrete is poured. Work with and provide guidance to the contractors responsible for pouring concrete and responsible for installing the building moisture protection system.

b. Anchor ductwork not more than 4-ft on centers to prevent floating. Use minimum 12-gauge wire or 16-gauge straps. Protect openings in ductwork with wood or metal blocking.
c. Pour concrete in maximum 12-inch lifts with each layer being allowed to set before pouring the next. Do not use power vibrators shall not be used in placement of concrete on or around ducts.

6. Fiberglass Ductwork (Ductboard)

a. Provide fiberglass ductboard only where specifically indicated on the drawings and in this specification.
b. Install per UMC-06 Standard 6-05 – Standard for Installation of Factory-Made Air Ducts and SMACNA Standard 1884-2003 – Fibrous Glass Duct Construction Standard.
c. The drawings indicate required clear inside dimensions for air flow.
d. Where a duct constructed of ductboard penetrates a wall or floor which requires a fire damper, smoke damper, or fire/smoke damper, install the FD, SMD or FSD in the wall per its listing, make sheet metal connections to the damper if required, and then transition back to ductboard.

7. Exterior Ductwork: Install ductwork as specified herein and insulate per Section 23 0700. Then enclose the exposed top and sides of ductwork with 28 gauge galvanized steel or 26-guage aluminum to protect the insulation. Repair any damage to the insulation jacket. Slope sheet metal enclosure to shed water.

C. Hangers and Supports

1. Securely support ducts per SMACNA and UMC Table 6-7. Provide support at each concentrated load and at each change in direction. Provide supports on each side of
2. rectangular ducts and equipment. Where vertical ducts pass through floors or roofs, support with angles or other steel members attached to minimum two opposite sides of duct. Size supports to rigidly support the ductwork. Provide lateral support.
3. Hangers for terminal units: Minimum four 1" x 1/8" galvanized steel straps or two angle trapeze supports.
4. Horizontal Round Ducts: 30 inches and larger in diameter: Provide 2" x 2" x 1/8" black steel rolled angle ring on 6-ft centers, and support from angle.

D. Plenums

1. Single Wall Plenums: Shop fabricated minimum 16 gauge galvanized sheet steel. Horizontal and vertical panels are to be fabricated of 2' x 10' sheets. Unless otherwise dimensioned on the Drawings, access door frames are not to exceed 16-3/4 inch width. Where door width exceeds 16-3/4 inches, vertical panels shall be fabricated around 2" x 2" x 1/4" angle. If the plenum height or width exceeds 9 feet, provide a 2-1/2" x 1/8" continuous galvanized steel strip between each horizontal and vertical seam. Provide high velocity cement at each joint during panel assembly. Panels are to be bolted as shown on the details or tack welded at the Contractor's option; however, enough panels must be bolted to allow removal of equipment from the plenums.

a. Plenum Access Doors: Minimum two fastening devices that can be operated on either side of the door; these devices to be readily operated and moving parts to have

bronze pins. All parts of the door shall be constructed of galvanized iron and shall be airtight. Latches: "Ventlock" No. 310 OAE.

2. Double Wall Plenums: Factory fabricated, Semco or equivalent. Submit shop drawings for review including overall configuration, construction details, access doors, erection drawings and structural calculations stamped by a registered structural engineer,.

   a. Factory fabricated, minimum 18 gauge galvanized steel outside, perforated galvanized steel inside, with 2-inch sound insulation between. Plenums downstream of final filters shall have solid inner panel.
   b. Heat transfer coefficient shall not exceed 0.0575 BTUH/SF-F at 75 deg F mean temperature. Pressure Ratings: 12 in. wg positive and 10 in. wg negative.
   c. Noise attenuation shall be as follows in decibels, re 10-12 watts.

	OCTAVE BAND							
	1	2	3	4	5	5	7	8
Attenuation, db:	26	30	36	41	34	36	44	37
Noise Absorption Coeff:	0.22	0.39	1.20	1.36	1.03	0.84	0.74	0.68

3.2 DUCTWORK ACCESSORIES

A. Dampers: Install dampers with shafts horizontal. Locate dampers so that actuators are readily accessible. Verify that dampers operate smoothly.

   1. Manual Dampers (Balancing Dampers): Damper Types D1 through D23 are all suitable for use as manual balancing dampers. Provide locking quadrants.
   2. Automatic Applications: The following damper types may be used for automatic applications: D4, D5, D6, D7, D21, D22 and D23. Provide damper actuators per Section 23 0900.

B. Flexible Connectors: Provide flexible connectors at locations indicated on the drawings and at the inlet and outlet of each fan directly connected to duct system. Select flexible connectors appropriate for the application. Provide steel spring vibration isolators spanning across flexible connections of isolated fan housings to prevent blow-apart due to horizontal displacement of fan housings.

C. Access Doors: Provide as required for access to all components located within ductwork. Locate to facilitate access to such components. Size as appropriate. In addition to locations specifically called out on the drawings or elsewhere in these specs, provide access doors at the following: FDs, SMDs, FSDs, instrumentation mounted within ductwork, fan bearings.

D. Turning Vanes: Provide turning vanes in square elbows of all supply ducts. Single wall turning vanes may be used in ducts up to 1500 FPM and 24-inch vane length. Provide double wall turning vanes in ducts exceeding either of these criteria.

E. Roof Curbs and Equipment Support Rails: Coordinate the location of roof curbs and rails with the roof structure, ductwork distribution, and other work. Install after roof deck is installed but before roof is insulated. Mount curbs and rails securely to deck per manufacturer’s recommendations. Provide counterflashing as required.

F. Louvers: Coordinate louver size and construction with structural and architectural openings to assure proper fit. Securely fasten louver to internal structural members to withstand a force of 25 lb/sf plus a safety factor of 3.0.

G. Instrumentation: Install duct thermometers and filter gauges so they are easily readable from the operator level.

3.3 DAMPERS FOR FIRE AND SMOKE CONTROL

A. Select FDs, SMDs and FSDs as appropriate to the application. Dampers may be rectangular or round, and single-section or multi-section as required, but shall not be less than the duct sizes indicated on the drawings nor larger than the maximum sizes per the UL listing for a given style of damper. Provide transitions and sleeves as required.

1. FSDs may be used where SMDs are indicated provided they meet the required ratings of the indicated SMDs and provided the FSDs are installed in accordance with their listing.

B. Install dampers in accordance with their listing. Install actuators and access doors on the side of the duct unless space conditions preclude this. Provide adequate clearance for proper operation, and minimum 36-inch clearance for servicing actuator.

1. When space conditions preclude installing actuators on the side, such components may be installed on the top or bottom of the duct provided good access to these components is maintained.
2. When size requires the use of multiple dampers, provide framing to ensure the dampers remain in place.
3. Provide a duct access door at each FD, SMD and FSD for inspection and maintenance. Provide minimum 1/2-inch high label, “SMOKE DAMPER,” “FIRE DAMPER,” or “FIRE/SMOKE DAMPER.”

C. Test all SMDs and FSDs after the system is installed to ensure proper operation based on both smoke and fire signals. Advise Owner minimum 2 weeks in advance and invite him to observe these tests. Submit a written report with a table which identifies each such damper (along with plans which indicate each such damper); gives its size, type and model number; the date on which it was tested; the test results; and places for the initials of the person performing test for the contractor and the person witnessing test for owner. Should any dampers fail to operate properly, service them and demonstrate proper operation. Reset all dampers when the testing is complete.

3.4 FILTERS AND FILTER GAUGES

A. Provide one set of MERV-7 temporary filters until testing and balancing is complete. Then immediately before the system is turned over to the Owner at the completion of the project, remove these filters and provide the specified filters.

3.5 TERMINAL UNITS

A. Install terminal units so that controls and piping components are readily accessible for normal service and maintenance. Provide minimum 3 ft clear in front of control panels.

3.6 GRILLES REGISTERS AND DIFFUSERS

A. Install grilles, registers & diffusers (GRDs) square with building construction. Mount sidewall GRDs minimum, 3-inches above floor level. If GRDs have provisions to adjust the direction of air flow, submit a written recommendation regarding the best direction for air flows, obtain written approval from the Owner's Representative, and adjust GRDs accordingly.

B. Verify frame types with architectural RCPs prior to ordering GRDs.

3.7 CLOSEOUT ISSUES

A. Leakage Testing

1. Pressure test not less than 25% of the installed ductwork of each system rated at 3 in wg or more, either positive or negative pressure. Advise Owner's Representative when systems will be ready for testing. For large systems separate tests may be made on different sections. The Owner's representative will designate the sections to be tested, but not more than 24 hours in advance of test. Cap ends of ducts as required and provide equipment as required for testing.
2. Measure duct leakage per the SMACNA HVAC Duct Leakage Test manual. Leakage shall not exceed the following:

   Lmax = CLP0.65, where
   Lmax = maximum permitted leakage, cfm/100 sf of duct surface area
   CL = Duct leakage class (cfm/100 sf at 1-inch wg)
   = 6 for rectangular sheet metal, rectangular fiberglass, and round flexible ducts
   = 3 for round and flat oval sheet metal or fiberglass ducts
   P = Test pressure. Test pressure shall match system pressure class.

3. If sample is defective, the contractor shall repair or modify the defective section and re-test it to demonstrate compliance. In addition, for each section which fails its original pressure test, the Owner's Representative will designate an additional ductwork section of similar size, for the Contractor to test. This section will be in addition to 25% area originally planned to be tested. .
4. Complete all leakage testing and repairs prior to concealing ducts.
5. Submit a test report that documents the test procedure and results. Include:

   a. Test equipment – model numbers, technical data, calibration data, etc.
   b. Drawings showing the extent of the systems tested.
   c. Test results.
   d. Dates, witnesses, and signatures of witnesses.

B. Testing and Balancing: Test and balance the complete air tempering system as specified in Section 23 0593. It is anticipated that the TAB effort will identify some system deficiencies. Work in a cooperative manner to identify the cause of these deficiencies. Where deficiencies aer due to defects in installation, or workmanship, repair as required and re-test to demonstrate proper performance.

C. Cleaning

1. All ducts, coils, housing, registers, grilles, fans, etc., shall be clean when installed and shall be kept clean until the system is completed. As the various parts of the system are installed, they shall be wiped or blown clean and openings taped dust-tight with heavy paper or cardboard until the system is completed and ready for testing. At that time all covers and protective wrappings shall be removed. Where one has been torn or previously removed, the duct, coil, register, etc., shall be carefully cleaned of any dirt or dust that has entered the opening.

END OF SECTION 23 3000

SECTION 23 3423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

C. UL Standard: Power ventilators shall comply with UL 705.

PART 2 -PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Acme Engineering & Mfg. Corp.
2. Aerovent; a Twin City Fan Company.
3. Carnes Company HVAC.
4. Central Blower Co.
5. Greenheck
6. Loren Cook Company

D. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

E. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1 Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

F. An Wheels: Aluminum hub and wheel with backward-inclined blades.

G. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

H. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

I. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

J. Pulleys: Cast-iron, adjustable-pitch motor pulley.

K. Fan and motor isolated from exhaust airstream.

1. Accessories:
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

L. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 16 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.

PART 3 -EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using restrained elastomeric mounts having a static deflection of 1 inch . Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

E. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

F. Support suspended units from structure using threaded steel rods and spring hangers. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

G. Install units with clearances for service and maintenance.

H. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

I. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

J. Install ducts adjacent to power ventilators to allow service and maintenance.

K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.

6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 3423

SECTION 23 3713 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Louver face diffusers.
5. Fixed face registers and grilles.
6. Laboratory Diffusers
7. Plastic Grilles

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Round Ceiling Diffuser:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. METALAIRE, Inc.

e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, white.
5. Face Style: Four cone.
6. Mounting: Duct connection.
7. Pattern: Fully adjustable.
8. Dampers: Radial opposed blade.

B. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Price Industries.
h. Titus.
i. Tuttle & Bailey..

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, white.

C. Perforated Diffuser:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Price Industries.
h. Titus.
i. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel backpan and pattern controllers, with steel face.
4. Finish: Baked enamel, white.

5. Duct Inlet: Round.

D. Louver Face Diffuser:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.
g. Tuttle & Bailey.

3. Devices shall be specifically designed for variable-air-volume flows.
4. Material: Steel.
5. Finish: Baked enamel, white.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Price Industries.
h. Titus.
i. Tuttle & Bailey.

2. Material: Steel.
3. Finish: Baked enamel, white.

B. Fixed Face Register:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anemostat Products; a Mestek company.
b. Carnes.

c. Hart & Cooley Inc.
d. Krueger.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.

2. Material: Steel.
3. Finish: Baked enamel, white

C. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.

2. Material: Steel.
3. Finish: Baked enamel, white.

2.3 LABORATORY DIFFUSERS

A. Laminar Airflow Diffusers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Price Industries.
h. Titus.
i. Tuttle & Bailey.

2. General Construction : Units shall be manufactured specifically for Laboratory usage. Aluminum construction, with a perforated face that extends below the ceiling plane. The units dhall be non-aspirating and deliver air in a radial pattern.
3. Finish: Baked enamel, white.

4. Provide a minium 6” backpan for even air flow distribution over the entire face of the diffuser.

B. Plastic Diffusers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.

2. See drawings for Plastic diffuser locations
3. Material: Plastic
4. Finish: Baked enamel, white

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 3713

SECTION 23 7313.1 OUTDOOR CENTRAL-STATION MAKEUP AIR-HANDELING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0505, Piping Specialties.

D. Section 23 0523, Valves.

E. Section 23 0700, HVAC Insulation.

F. Section 23 0900, Facility Management System, for temperature control valves, meters and instrumentation.

G. Section 23 2313, Refrigerant Piping System & Equipment

H. Division 26, Electrical.

1.3 SUMMARY

A. Section Includes:
   1. Modular Outdoor Central Station Variable-Air-Volume Air-Handling Units.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/100 where "L" is the unsupported span length within completed casings.

B. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, and operators.
   6. Filters with performance characteristics.

1.6 ACTION SUBMITTALS

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   1. Unit dimensions and weight.
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      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, and operators.
   6. Filters with performance characteristics.
   7. MAU manufacturer shall provide the following information with each shop drawing/product data submission:
   8. Dimensioned arrangement drawings for each MAU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
   9. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
   10. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
   11. All performance data, including capacities and airside and waterside pressure drops, for components.
   12. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
   13. For units with multiple fans, a fan curve shall be provided showing the performance of the entire bank of fans at design conditions. In addition, a fan curve shall be provided showing the performance of each individual fan in the bank of fans at design conditions. Finally, a fan curve shall be provide showing the performance of the bank of fans when one fan is down. The percent redundancy of the bank of fans with one fan down shall be noted on the fan curve or in the tabulated fan data.
   14. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section

location within the MAU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.

15. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
16. An electrical MCA – MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).
17. Sound data shall be provided using AHRI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.
18. The MAU manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.
19. The MAU manufacturer shall list any exceptions to the specification.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: Two <2> set(s) for each air-handling unit.
   2. Gaskets: One <1> set(s) for each access door.

1.9 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

G. AMCA Publication 99 – Standards Handbook.

H. AMCA Publication 611 – Certified Ratings Program – Airflow Measurement Performance

I. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.

J. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings.

K. ANSI/AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.

L. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.

M. ANSI/AHRI Standard 430 - Central Station Air Handling Units.

N. ANSI/UL 900 – Standard for Safety Air Filter Units.

O. AHRI Standard 260 – Sound rating of Ducted Air Moving and Conditioning Equipment.

P. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat Exchangers.

Q. ASHRAE Standard 111 – Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

R. ASTM B117 - Standard Practice for Operation Salt Spray Apparatus.

S. ASTM E477 – Standard Test Method for Measure Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

T. NFPA 70 – National Electrical Code®.

U. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilation Systems.

V. UL 1995 – Standard for Safety Heating and Cooling Equipment

W. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

X. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard 430.

Y. Air handling units with fan sections utilizing multiple fans shall be rated in accordance with AHRI Standard 430 for airflow, static pressure, and fan speed performance.

Z. Airflow monitoring station: Certify airflow measurement station performance in accordance with AMCA 611.

AA. ISO 9001 Certification.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.11 REGULATORY REQUIREMENTS

A. Agency Listings/Certification

B. Unit shall be manufactured to conform to UL 1995 and shall be listed by UL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL as directed by the representative, at no additional expense to the owner.

C. Certify air handling units in accordance with AHRI Standard 430. Units shall be provided with certification label affixed to the unit. If air handling units are not certified in accordance with AHRI Standard 430, contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

D. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

E. Certify airflow monitoring stations are tested for differential pressure in accordance with AMCA 611 in an AMCA registered laboratory and comply with the requirements of the AMCA Certified Ratings Program. Airflow monitoring station shall be licensed to bear the AMCA Seal.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. All units will be shipped with an integral base frame designed with the necessary number of lift points for safe installation. All lifting lugs are to be utilized during lift. The lift points will be designed to accept standard rigging devices and be removable after installation. Units shipped in sections will have a minimum of four points of lift.

C. Units shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging and final placement of MAU sections.

D. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

E. Air handling units shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

F. Installing contractor shall be responsible for storing MAU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.13 UNIT CONFIGURATION

A. See plans.

1.14 START-UP AND OPERATING REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

1.15 WARRANTY

A. MAU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trane
2. Noertek
3. York

2.2 GENERAL

A. Unit layout and configuration shall be as defined in project plans and schedule. Furnish and install where shown on the plans, mechanical frame style air handling units specifically designed for OUTDOOR application with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications and meet the requirements issued from the National Institue of Health (NIH). All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

2.3 FACTORY TESTING AND QUALITY CONTROL

A. Factory Leak Testing: The unit manufacturer shall provide a witnessed factory leak test on selected units. The cabinet shall be tested at the unit's design operating static pressure 8" of differential static pressure across the cabinet exterior walls) for both the high and low pressure sides. Cabinet leakage shall not exceed a Leakage Class rating as defined by ANSI/ASHRAE Standard 111. All supply and return air openings shall be sealed. The air shall then be pumped into the unit until the appropriate operating pressures are achieved. Air flow measurements shall be performed in compliance with AMCA Standard 210. The testing shall be performed at the factory. The manufacturer shall notify contractor and/or owner 10 days prior to test for witnessing. (Travel expenses are not part of this contract). Owner's representative shall select one unit to be tested at the time of release. A written test report shall be prepared by the manufacturer and issued to the Owner's representative.

2.4 UNIT CASINGS

A. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and AHRI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

B. Rigging Provision – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

C. Unit Base - Floor: Unit perimeter base rail shall be fabricated using heavy gauge steel. C-Channel cross supports shall be welded to perimeter base steel and located on maximum 24" centers to provide support for internal components. Base rails shall include lifting lugs at the corner of the unit or each section if de-mounted. Internal walk-on floor shall be 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pined

insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.

D. Unit Casing – The construction of the air handling unit shall consist of a (1" x 2") steel frame with formed 20 gauge galvanized steel exterior casing panels. The exterior casing panels shall be attached to the gasketed (1 x 2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit's structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing panels are made from 16 gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 8" positive pressure). The air handling unit casing shall be of the "no-through-metal" design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there's no path of continuous unbroken metal to metal conduction from inner to outer surfaces. All panel seams shall be caulked and sealed for an airtight unit.

E. The exterior panel finish shall be Painted with a polyester resin coating designed for long term corrosion resistance meeting or exceeding (ASTM B-117) Salt Spray Resistance at 95 degrees F. 2,500 hrs. and (ASTM D-2247) Humidity Resistance at 95 degrees F. 2,500 hrs. The color shall be sandstone.
   1. Note: If manufacturer cannot provide thermal break (no through metal) and or removable exterior panel construction it must be noted as an exception on the bid.

F. Double Wall Liner - Each unit shall have double wall construction with 20 gauge solid galvanized steel liner in the entire unit.. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.

G. Insulation - Entire unit to be insulated with a full (R-19) closed cell foam insulation. Foam shall be ecomate 0-, 0-, (Non VOC) UL 94HF1 rated. All insulation edges shall be encapsulated within the panel. All field penetrations must be completely sealed by installing contractor.
   1. Note: Non UL 94HF1 rated foam is not allowed.

H. Access Doors - The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
   1. Access doors shall be provided with a 10 x 10 dual thermal pane safety glass window.
   2. All doors shall be the maximum height allowed by the unit height.
   3. Door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.
   4. Refer to Product Data for specific information on which sections are supplied with an access door, the door location, a single handle and a window.

I. Service Light: LED 100-W vaporproof fixture with switched junction box located outside adjacent to door.
      a. Locations: Fan sections, mixing section, filter section, and access sections.

J. Condensate Drain Pans:
   1. Condensate / Drain Pans - IAQ style drain pans shall be provided under all cooling coils as shown on the drawings. The drain pan shall be fabricated from 16 gauge 304 stainless

steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4" MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage.

2. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends).
   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches deep.
3. Integral part of floor plating.
4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   a. Minimum Connection Size: NPS 2
5. Material: Stainless Steel.
6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

K. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.5 FACTORY-SUPPLIED CURB

A. Outdoor MAU will be provided with a factory-supplied roof curb. Curb will be shipped to jobsite disassembled. Contractor will be responsible for assembly and mounting to roof structure per the Roof Curb Manual. The factory-supplied curb shall include a curb section for the pipe cabinet(s).

B. Refer to the Roof Curb Detail drawing and Product Data section of submittal for height of factory-supplied roof curb(s).

2.6 EXTERNAL PIPE CABINET

A. Piping cabinet shall be supplied factory-assembled of the same construction as the main unit casing. Piping cabinet is shipped separate to be field installed on the side of the unit.

B. Refer to the plans for specific information on which sections are supplied with a corresponding pipe cabinet and pipe cabinet access doors.

2.7 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
   1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
      a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
      b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Fan sections shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.

C. Provide fans and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

D. All fans, shall be mounted on spring isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with 2-inch spring isolators. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements.

E. Fan sections containing multiple fans shall be provided as indicated on the schedule and drawings. Each fan shall operate in parallel to each other fan in the array. The fans shall be SWSI plenum type with high efficient AF blades. Fans shall be direct-driven. Fan wheels shall be aluminum. The Hp characteristic of the fans shall be non-overloading.

F. Fan sections containing multiple fans shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

G. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with a 2-10 VDC output for each fan. Signal shall be proportional to air velocity.

H. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   4. Mount unit-mounted disconnect switches on exterior of unit.
   5. Motors shall meet or exceed all NEMA Standards Publication MG 1 – 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
   6. Fan Motors shall be heavy duty, NEMA Premium efficient ODP, operable at 460 volt/60 Hz/3 phase, exceeding the EPAct efficiency requirements.
   7. Direct-driven fan sections shall use 4-pole (1800 rpm), NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads.

8. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

2.8 HUMIDIFIER SECTION

A. Steam humidifier shall be a steam separator type providing full separation ahead of a control valve which discharges through an internal drying chamber. Steam humidifier shall be electrically controlled. The humidifier capacity shall meet or exceed the capacity specified in the mechanical schedule. The size and number of distribution manifolds shall be sized so all steam is absorbed by the air before reaching the next component in the air stream. Humidifier shall receive steam at supply pressure and discharge at atmospheric pressure. Humidifier shall be furnished with inlet strainer and float and thermostatic traps or a bucket steam trap. Separating chambers shall be of a volume and design that will disengage and remove water droplets and particle matter when the humidifier is operating. The distribution manifold shall provide uniform distribution over its entire length and be jacketed by steam to assure that vapor discharged is free of water droplets.

2.9 COIL SECTION

A. General Requirements for Coil Section:
   1. Comply with ARI 410.
   2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
   3. Coils shall not act as structural component of unit.
   4. See equipment schedule for performance data

B. Coils section side panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

C. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

D. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

E. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

F. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle shall be degreased and cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

G. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate

stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the primary drain pan.

H. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.

I. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

J. Hydronic Coils
1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
3. Headers shall be constructed of round copper pipe or cast iron.
4. Tubes shall be 1/2 inch O.D., minimum tube thickness of 0.016 inch thick copper. Fins shall be aluminum.

2.10 INLET HOODS

A. Inlet hoods are provided on the outside air openings and equipped with high performance moisture eliminators to minimize water carryover from the outside into the unit casing. Eliminators also perform the function of a bird screen to prevent nesting.

B. Refer to the unit As-Built and Product Data section for specific information on which sections are supplied with inlet hood.

C. The following specifications apply only to units with outside air and return air dampers, with actuators. The 5 year warranty applies only to these items.

D. This unit contains Economizer that meets or exceeds all mandatory requirements prescribed by Title 24, including but not limited to:

E. 5 yr parts only warranty

F. Successfully tested to 60,000 Actuations

G. Less than 10 cfm/sq.ft. of damper leakage at 1" WG per AMCA 500L

2.11 AIR FILTRATION

A. General Requirements for Air Filtration Section:
1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side (access side)

B. Provide factory-fabricated filter section of the same construction and finish as unit casings. Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by AAF, FARR or equal. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters. The filters shall be as manufactured by Farr, Purolator, AAF or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.

C. Filter Gauge: Each Filter bank shall be furnished with: (Magnehelic / Photohelic) filter gauge with a 4 ¾" OD white static pressure dial with black figures and zero pointer adjustment. Dwyer Series 2000 Air filter gauge Dwyer Mark 25 Inclined manometer (DWYER 250 AF).

D. Flat Racks - Filter racks shall be completely factory assembled and designed for industrial applications. Filter racks shall be fabricated from no less than 16 gauge galvanized steel. Filter racks shall be applied in low efficiency filter applications and will be either upstream or side accessible. Side accessible filter racks shall have an oversized access door on the exterior of the air handler, centered on the filter rack for easy filter removal. Upstream access filter racks shall have one central access cover per row of filters centered in the unit for easy access. Filter racks over 72" in length shall require an angle center reinforcement support. Filter racks shall be designed for a maximum of 500 fpm, or meet or exceed the area specified in the mechanical schedule.

E. Medium Efficiency Pleated Filters - Filters shall be 2" thick, 30% efficient. Filter media shall be 100% synthetic. The filter shall have an average efficiency of 25 30% and an average arrestance of 90 92%. The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76. The effective media shall not be less than 4.6 square feet of media per 1.0 square foot of filter face area, and shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm approach shall not exceed 0.28" wg.

F. High Efficiency Rigid Filters - Filters shall be 12" deep high performance, pleated, totally rigid and totally disposable type. Each filter shall consist of high density glass fiber media, media support grid, contour stabilizers and enclosing frame. Filter media shall be laminated to a non-woven synthetic backing to form a lofted filter blanket. The filter media shall have an average efficiency of 95%. The media support shall be a metal grid with an effective open area of not less than 96%. The metal grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull-away. The metal grid shall be formed in such a manner that it effects a tapered radial pleat design. The grid shall be designed to support the media both vertically and horizontally. Filters shall be listed Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52.1-76. Contour stabilizers shall be permanently installed on both entering air and exit air sides of the filter media pack to ensure that the tapered radial pleat configuration is maintained throughout the life of the filter. The filter shall be capable of withstanding a 10" wg pressure drop without noticeable distortion of the media pack. The enclosing frame shall be constructed of galvanized steel. It shall be constructed and assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The periphery of the filter pack shall be continuously bonded to the inside of the enclosing frame, thus eliminating the possibility of air bypass. The enclosing frame shall be equipped with protective diagonal support members on both the entering air and air exit sides of the filters.

2.12 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 3000-fpm face velocity through damper and pressure differential.

B. Damper Operators: Comply with requirements in Section 23 0900 "Instrumentation and Control for HVAC."

C. All dampers shall be internally mounted. Dampers shall be Temtrol TD-6 or approved equal. Provide Class 1 rated, ultra-low leak dampers (less than 3 cfm/sq ft. @ 1" w.g.) as indicated on the unit drawings. Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated or stainless steel tubular steel shaft for a non-slip operation. Shaft bearings shall be spherical – non corrosive nylon to eliminate friction and any metal to metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge galvanized steel frame.

D. Airflow measuring stations shall be provided and located in the outside and/or return air paths as indicated on the schedule and plans to measure airflow. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage.

E. The airflow measurement station shall measure up to 100 percent of the total outside air and/or return air. The airflow measurement station shall be capable of measuring down to 300 fpm. The airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the MAU interior.

2.13 DISCHARGE PLENUM SECTION

A. Plenums shall be provided as indicated in the schedule and plans to efficiently turn air and provide acoustical attenuation. Discharge plenum opening types and sizes shall be scaled to meet pressure drop requirements scheduled and align with duct takeoffs.

2.14 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units level on concrete bases. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units with flexible connectors.

D. Connect condensate drain pans using NPS 2, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot-Water Piping: Comply with applicable requirements in Section 23 2113 "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 3300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
   2. Charge refrigerant coils with refrigerant and test for leaks.
   3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

B. After the Mechanical Contractor has provided all water and refrigerant piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor and factory-authorized service representative shall then perform startup of the equipment.
   1. The Control’s Contractor shall be scheduled to be at the job site at the time of the equipment start up.
   2. Perform the following tests and services and submit a report outlining the results:
   3. Record date, time, and person(s) performing service.
   4. Lubricate all moving parts.
   5. Check all motor and starter power lugs and tighten as required.

6. Verify all electrical power connections.
7. Conduct a start up inspection per the MAU manufacturer's recommendations.
8. Record fan motor voltage and amperage readings.
9. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
10. Check fan for excessive vibration.
11. Check V belt drive or coupling for proper alignment.
12. Check V belt drive for proper tension. Tighten the belts in accordance with the MAU manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the MAU manufacturer.
13. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
14. Disengage all shipping fasteners on vibration isolation equipment.
15. Check safety guards to insure they are properly secured.
16. Secure all access doors to the fan, the unit and the ductwork.
17. Switch electrical supply "on" and allow fan to reach full speed.
18. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.
19. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving hot water temperatures and flow, refrigerant pressures and temperatures, and outside air temperature.
20. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm
21. Measure and record motor electrical values for voltage and amperage.
22. Manually operate dampers from fully closed to fully open position and record fan performance.

C. Check all control sequences.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 7313.1

SECTION 23 8113 - TERMINAL AIR-CONDITIONERS

PART 1 - GENERAL

1.1. SUMMARY

A. Section includes packaged terminal air conditioners and their accessories and controls, in the following configurations:

1. Fan & Coil Units for 2 pipe or 4 pipe application.
2. Split system fan coils and remote outdoor refrigerant condensing units.

1.2. SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For packaged terminal air conditioners. Include plans, elevations, and sections, details for wall penetrations, seismic bracing, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

D. Field quality-control reports.

E. Operation and maintenance data.

1.3. QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007.

1.4. WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.
2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Substantial Completion, including only components and excluding labor.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Basis-of-Design Product: (Split systems) Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Daikin or Mitsubishi

2.2. MANUFACTURED UNITS

A. Indoor Units

1. Indoor Units shall be as specified on the Equipment Schedule on the drawings..
2. Air-conditioning and heat-pump indoor units shall be a Daikin split system with Variable Speed Inverter Compressor technology. The system shall consist of a wall or ceiling mounted (see plans) indoor section with wired, wall mounted controller and a horizontal discharge, single phase outdoor unit.
3. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
4. The units shall be rated in accordance with Air-conditioning Refrigeration Institute’s (ARI) Standard 210 and bear the ARI Certification label.
5. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
6. A dry air holding charge shall be provided in the indoor section.
7. The outdoor unit shall be pre-charged with R-410a refrigerant for 150 feet of refrigerant tubing.
8. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit, using the Daikin Control system. For A-Control, a three (3) conductor AWG-14 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.
9. The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit. Field wiring shall run directly from the indoor unit interconnected by a single non-polar two-wire AWG-16 stranded cable to the wall mounted controller with no splices. The control system between the outdoor unit and indoor unit shall be supplied from the outdoor unit using the Daikin Control system. The system shall be capable of automatic restart when power is restored and after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostic

codes for indoor and outdoor units shall be displayed on the wired controller panel. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

10. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents in English and Spanish. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Auto/Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).
11. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.
12. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,500 feet (500 meters).
13. The control voltage from the wired controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.
14. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

B. Outdoor Units

1. Furnish and install air cooled condensers located on building roof or ground as shown on the drawings. Air cooled condenser shall be of type and capacity as specified in the Mechanical Equipment Schedule on the drawings. The outdoor unit shall be compatible with the three different types of indoor units (wall mounted, ceiling suspending, and four way ceiling cassette). The connected indoor unit must be of the same capacity as the outdoor unit. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.
2. The outdoor unit shall be capable of operating at 0°F (-18°C) ambient temperature without additional low ambient controls (optional wind baffle may be required).
3. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) indoor unit to outdoor unit,
4. System shall have a maximum refrigerant tubing length of 100 feet (30 meters) for the 12,000 and 18,000 and 165 feet (50 meters) for the 24,000, 30,000 and 36,000 between indoor and outdoor units without the need for line size changes, traps or additional oil.

C. Piping

1. Refrigerant piping materials and installation shall be in accordance with the best working

and piping practices for Freon refrigerants. The Contractor shall install the refrigerant piping using ACR Type "L" hard drawn copper tubing, Federal Specification WW-T- 749, with silver solder joint. All piping shall be installed in a straight manner, free from traps, and shall be provided with plugged or capped ends, as it is erected, to prevent dirt from entering. The piping system shall be provided with gauges as required for the operation of the system. The piping is shown schematically on the drawings, verify exact arrangement and pipe sizing with equipment manufacturer.

D. Four Pipe Fan Coil Units

1. Description: Factory-assembled and -tested, , packaged terminal air conditioner with room cabinet, fan , motor, heating hot water coils, and chilled water cooling coils.. Units shall include air filters, and where exposed to view, stamped RA grilles, and stamped horizontal facing supply grilles.
2. Chassis

   a. Cabinet: 0.052-inch- thick steel with removable front panel with concealed latches.
   b. Mounting: Suspended.
   c. Finish: Baked enamel.
   d. Access Door: Hinged door in top of cabinet for access to controls.
   e. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
   f. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
   g. Filters in first paragraph below are optional feature. Washable filters may not comply with requirements in ASHRAE 62.1-2004 for a minimum MERV 6. Verify filter efficiency with manufacturers.

3. Filters: 1” thick throwaway, Merv 8.
4. Condensate Drain: Drain pan and piping to direct condensate to building waste and vent piping.
5. Comply with ASHRAE 62.1-2010 for drain pan construction and connections.
6. Coils: Refer to Section 23 82 16 for requirements of heating and cooling coils.

PART 3 - EXECUTION

3.1. INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."

C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2. FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Packaged terminal air conditioners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 8113

SECTION 23 8216 - AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes heat recovery air coils that are not an integral part of air-handling units.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1-2010, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 WATER COILS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Aerofin Corporation.
2. Carrier Corporation.
3. Coil Company, LLC.
4. Dunham-Bush, Inc.
5. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
6. Super Radiator Coils.
7. Trane.
8. USA Coil & Air.

D. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

E. Minimum Working-Pressure/Temperature Ratings: 200 psig.

F. Source Quality Control: Factory tested to 300 psig.

G. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

H. Fins: Aluminum, minimum 0.006 inch thick.

I. Headers: Seamless copper tube with brazed joints, prime coated.

J. Frames: Galvanized-steel channel frame, minimum 0.064 inch thick for slip-in mounting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

E. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

F. Install piping adjacent to coils to allow service and maintenance.

G. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Instrumentation and Control for HVAC" and other piping specialties are specified in Division 23 Section "Hydronic Piping."

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 8216

SECTION 23 8413 - SELF-CONTAINED STEAM HUMIDIFIERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Self-contained, elec-to-steam type with steam generator and dispersion tubes

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, distributer tubes/manifolds, and attachments to other work.

1. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which humidifiers will be attached.

B. Seismic Qualification Data: Certificates, for humidifiers, accessories, and components from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.9 COORDINATION

A. Coordinate location and installation of humidifiers with distributer tubes/manifolds. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 PRODUCTS

2.1 SELF-CONTAINED ELEC HUMIDIFIERS

A. Elec-to-steam type with steam generator and dispersion tube by same manufacturer for a complete system with single-source responsibility, fully modulating over 30:1, suitable for use with softened water at 50-120F.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with AHRI 640.

D. Comply with UL 998.

E. Cabinet:

1. Powder-coated-steel enclosure. Cabinet is factory insulated for safe operating surface temperature.
2. Enclosure houses internal components, controls, and control panel.
3. Hinged or removable cover, keyed to restrict unauthorized access.
4. Weatherproof outdoor enclosure, with automatically controlled heating and ventilating system to maintain minimum operating conditions within the enclosure.

F. Controls:

1. Controls: Provide all necessary safety and operating controls. Unit shall be capable of control to +/- 3% RH. Provide BACnet interface with the Facility Management System provided by others.
2. Solenoid fill valve and automatic drain valves maintain water level. Include stainless-steel inlet strainer, stainless-steel solenoid valve with flow regulator, and fill tee with built-in air gap to prevent back siphoning.
3. Field-adjustable timer to control drain/fill cycle for flush duration and interval.
4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
5. Set-point adjustment.
6. Float switches for water-level control and to shutdown heat exchanger upon low-water condition.
7. Over-temperature heater shutdown.
8. Aquastat maintains minimum water temperature in tank during short periods of no demand.
9. Thermal safety switch monitors stack temperature for shutdown on overheating.
10. Foaming detection and correction.

A. Control Panel:

1. Microprocessor-based control system for modulating control.
2. Factory-wired disconnect switch.
3. Liquid-crystal display.
4. Programmable keypad.
5. Low-voltage control circuit.
6. Diagnostic, maintenance, alarm, and status features.
7. Internal electrical controls prewired to appropriately marked terminals for field connection.
8. Electrical terminals for connection to each controlling device and alarm.
9. NEMA 250, Type 3R, to comply with environmental conditions at installed location.
10. Building Automation System Interface:
    a. Full Communication System Interface: BACnet.

B. Area Dispersion Accessory: Stainless-steel tube with integral fan that discharges vapor directly into occupied space.

C. Atmospheric Steam Distributer Tube(s): Single or multiple, atmospheric steam distributer tube extending across entire width of airhnadler and equipped with mounting brackets on ends. Nozzles/metered orifices are spaced evenly along distributer tubes and provide dry and uniform steam distribution.

1. Material: Stainless steel, Type 304.

2. Dispersion Tubes: Direct steam injection type, factory fabricated, vertical tube configuration with stainless steel casing to completely surround unit, stainless steel headers and tubes, and connections for steam inlet and condensate outlet. See schedules for anticipated conditions of service. Configure dispersion tube so that the distance between the dispersion tube and the next downstream component is minimum 150% of the worst case absorption distance. Air pressure drop shall not exceed 0.10-inches at maximum air flow.
3. Locate upstream of cooling coil.

D. Approved Manufacturers: Dri-Steem, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.

B. Seal all penetrations with flange.

C. Install stainless-steel drain pan.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from tube(s)/manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.

D. Install tube(s)/manifold supply piping pitched to drain condensate back to humidifier or as recommended by manufacturer.

E. Equipment Mounting:

1. Install floor-mounted humidifiers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Install Elec steam generators according to NFPA 54.

G. Install all manufacturer-furnished accessories in accordance with manufacturer's written installation instructions.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.
2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install piping specialties furnished by manufacturer but not factory mounted.

C. Install piping from safety relief valves to nearest floor drain.

D. Connect combustion-air inlet to intake terminal using PVC piping with solvent-cemented joints. Run from boiler connection to outside and terminate adjacent to flue termination.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.
3. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between control devices.

C. Connect control wiring according to Section 260523 "Control Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service agent:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Humidifier will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION 23 8413

SECTION 25 3500 – FIELD DEVICES

PART 1 - GENERAL

1.1 OVERVIEW

A. The Scope of Work described in this Section and as shown on the Control Drawings shall be provided and installed under this Section of the Specification.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 23 05 00, Common Work Requirements.

B. Section 23 05 05, Piping Specialties.

C. Section 23 05 23, Valves.

D. Section 23 05 49, HVAC and Electrical Installation Coordination.

E. Section 23 05 50, Variable Frequency Drives.

F. Section 23 05 93, Testing, Adjusting and Balancing.

G. Section 25 50 00, Controls - Environmental Management System.

1.3 SCOPE

A. It is the intent of this Section to specify the field devices necessary to provide fully automatic control for all systems as shown in the Control Drawings, stated in the sequences of operation, indicated in the electrical ladder diagrams, or as otherwise required by the Contract Documents. Some equipment controls are specified to be provided in other portions of the Contract Documents, including Owner-furnished equipment. As work of this Section, coordinate with these other suppliers and trades to provide a completely and fully functional EMS.

B. It is the responsibility of the bidder to read and conform to all Sections of the Specifications, review all Contract Drawings of all divisions, and coordinate with all equipment suppliers of material specified under other Sections of the Specifications

1.4 SUBMITTALS

A. Refer to Section 25 5000 for submittal requirements.

1.5 RECORD DRAWINGS

A. Refer to Section 25 5000 for record drawing requirements.

1.6 SYSTEM TESTING

A. Refer to Section 25 5000 for system testing requirements.

1.7 TRAINING

A. Refer to Section 25 5000 for training requirements.

1.8 SERVICE AND WARRANTY

A. Refer to Section 25 5000 for service and warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Required brand names, no substitutions will be accepted:

1. Steam Control Valves shall be manufactured by Siemens Building Technologies, Inc.
2. Energy Valves shall be manufactured by Belimo.

2.2 FIELD DEVICES

A. All devices and equipment shall comply with all applicable local code requirements.

1. Temperature Sensors - with accuracy of + .5 deg F @ 77 deg F).
2. Humidity Sensors - Duct Sensor with accuracy of + 3% RH @ 77 deg F, range of 10% to 90% RH, including hysteresis, linearity, and repeatability. Room Sensor 1% RH, range of 10% to 80% RH.
3. Pressure Sensors – sized as needed for best accuracy.
4. Dampers, sized for specific application.
5. Damper Operators, sized for specific application.
6. Automatic Control Valves, sized for specific application (provide separate Valve Schedule). All valves shall be installed with plastic engraved name tags to match Valve Schedule. Attach with stainless chain. Sequence staging shall be provided via the DDC system. Control valves over ½" shall be provided with a means to manually position the valve.
7. Low Temperature Detection Stat – Manual reset. Shall be hard-wired to motor control center with a second contact for DDC alarm generation.
8. All field mounted valves, damper actuators, and sensors shall have engraved type nameplates attached by stainless braid or other permanent type attachment. ID tag shall identify the device as shown on submittal drawings. Dymo type labels shall not be acceptable.
9. Field devices such as relays shall be located in each equipment's respective control panel. Wall mounted devices are not acceptable. All field control panels containing devices shall be equipped with a hinged, lockable door. Each panel, and all devices inside each panel, shall bear engraved identifications as shown on submittal drawings. Do not attach

nameplates to devices, rather attach to mounting back plane. All devices shall be wired through a wiring terminal strip located within the panel. Each terminal shall be identified to match submittal drawings.

B. Sensors

1. General: Provide temperature sensors for duct, immersion, remote probe, and outside air applications.

   a. Sensor time constant response to temperature change time shall be less than 3 seconds per degree change. Sensors requiring field-calibration shall not be acceptable. All sensors shall be precise and accurate so that they do not require adjustments or calibrations. Linearizing, ranging and resistance change versus temperature curve interpretations, where required, shall be made by software programming.
   b. Minimum sensor operating ranges shall be as follows:

      1) Chilled Water 30°F to 100°F.
      2) Condenser Water 30°F to 150°F.
      3) Air Systems 0°F to 150°F.
      4) Outside Air 0°F to 120°F.
      5) Hot Water 40°F to 240°F

   c. Sensor accuracy shall be ±0.1% at 32°F for platinum and nickel sensors and ±0.4°F for thermistor sensors. Sensor to controlling device end to overall system accuracy, including errors associated with the sensor, lead wire and analog to digital conversion shall be ±0.5°F for platinum and nickel sensors and ±1°F for thermistor sensors.

2. Duct Sensors: Provide flanged or threaded probe type sensors designed for duct type mounting. Sensor shall be encapsulated in an aluminum probe 4" long except where averaging sensors are specified. Sensors shall include a suitable junction box for terminating sensor wiring and shall include a lagging protrusion where installed in externally insulated ducts. Adjacent to each sensor provide a test hole plugged with a removable cap or plug to be used for test and calibration purposes. All sensors shall be located in the most easily accessible location while providing accurate sampling.
3. Immersion Sensors: Provide Immersion type sensors with a 1/2" OD threaded fitting for direct installation in a thermo well. The probe shall be encapsulated in an aluminum, brass or stainless steel jacket and shall be installed in a stainless steel thermowell suitable for installation in a 3/4" NPT threaded fitting. Sensors shall include a suitable junction box for terminating sensor wiring. Thermowells shall have pressure and temperature ratings suitable for their application. Wells for insulated piping shall have a 2-1/2" lagging protrusion. Locate wells so the sensing probe will give a true and correct reading. Install wells on the sides of pipes and so as not to cause undue restriction in small piping. Where wells are located in pipe lines 1-1/2" and smaller, provide a section of pipe of such diameter that the net area of the pipe line will not be reduced by the thermometer well. All wells shall be filled with silicon and complete with caps and chains. Wells shall be installed on a 45-degree angle into the direction of water flow in the monitored piping. Temperature probes and wells shall have the following insertion lengths.

Pipe Diameter	Orientation	Insertion Length
4"	Horizontal	2-1/2"
4", 6"	Vertical	4-1/2"
6", 8"	Horizontal	4-1/2"
8", 10"	Vertical	6-1/2"
>8"	Horizontal	6-1/2"
10"	Vertical	10"

4. Remote Probe Sensors: Provide remote probe sensors with sensing elements encapsulated in a nominal 2" stainless steel sheath suitable for return air or strap-on mounting. Sensors shall include a nominal 3' lead section and a suitable junction box for terminating sensor wiring.
5. Outside Air Sensors: Provide shielded, weatherproof outside air sensors with sensing elements encapsulated in a nominal 2" stainless steel sheath suitable for outdoor applications. Sensors shall include a waterproof junction box or conduit body for terminating sensor wiring and a removable sun shield. Location shall be on exterior North-facing sidewall at a level requiring a 6' stepladder for servicing. Do not install at ground accessible level.
6. Space temperature sensors shall be electronic type with a range of 32 deg F to 104 deg F. These sensors shall require no field calibration, but will be provided with a zero and span adjustment. They will have an accuracy of ± 0.4 deg F. All sensors shall use shielded cable between the sensor and the controller. Space temperature sensors for use with ASC's shall be provided with set point adjustment, local occupancy indication, communication jack for LAN connection, override switch.

C. Pressure Sensors

1. Overpressure Protection: Provide pressure sensors impervious to instantaneous pressure changes of 150 percent of working pressure.
2. Adjustment: Provide sensors with external adjustable span, adjustable zero and pulsation suppression (averaging type).
3. Finished Spaces: Conceal pressure sensors in recessed stainless steel housing with removable perforated brushed stainless steel cover.
4. Sensor Characteristics: Provide pressure sensors with the following characteristics:

    a. Ambient Temperature: 40 to 140 degrees F.
    b. Isolation Valves: Provide pressure sensors with stainless steel needle isolation valves between each sensor and sensor pressure source. Provide differential pressure sensors with 3 valve manifold for isolation and nulling.
    c. Siphon: On steam systems provide pressure sensors with a pigtail siphon between the sensor isolation valve and sensor. Provide condensate wells and blowdown valves for differential pressure sensors.
    d. Provide switching type sensors with platinum alloy, silver alloy or gold plated wiping contacts rated for the application, voltage and power levels.
    e. Provide valved calibration taps adjacent to each pressure sensor for calibration.

D. Differential Pressure Analog Sensors

1. Types: Provide differential pressure analog sensors of the solid state preamplifier types for electronic systems.

E. Flow Sensors

1. General: Provide sensors for measuring flow in piping and ductwork that are compatible with static pressure and differential pressure analog inputs of the electronic controllers served.
2. Turndown: Provide sensors with an output which gives a continuous mathematical function over the full range of flow from maximum to minimum required.
3. Location: Mount flow sensor concealed in public spaces or exposed in mechanical equipment room.

F. Water Differential Pressure Sensors.

1. Types: Provide digital electronic pressure sensors as required by the Sequence of Operations and control diagrams.
2. Provide sensing elements of the differential type measuring controlled medium and standard reference pressures.
3. Water differential pressure sensors shall have a minimum range of 0 to 50 psid with overpressure protection as required by the application. Install sensor with a 3 valve manifold. Provide siphons and pressure snubbers as required.

G. CO2 Sensors

1. The CO2 sensor for demand control ventilation shall be a non-dispersive infrared sensor. The diffusion gas chamber in the sensor should incorporate a reflective light pipe or waveguide surrounded by a gas permeable 100 angstrom molecular sieve filter that prevents particulate contamination of the sensor. The infrared detector in the sensor should be internally heat stabilized at 50 deg C to eliminate external temperature interference. All adjustments to the sensor including output signal, output scaling, relay set point, relay dead-band, resetting CO2 calibration, and full two point calibration capabilities should be made via a user friendly PC based program that can communicate with the sensor.
2. Sensor shall have 20-30 VAC power input, 0-10V or 4-20mA analog output max. range, 0-10,000 ppm max. or factory set 0-5000 ppm measuring range.
3. Sensor shall be manufactured and warranted for 1 year by the controls vendor. During the initial 1 year period, recalibration required to keep instruments within original specifications shall be performed by the controls vendor at no cost to NMSU.
4. Provide at least one spare sensor to NMSU for future service needs. If the total count of sensors exceeds 10 provide at least two spare sensors.

H. Actuators

1. General: Provide electric motor driven actuators (operators) arranged "Fail Safe" in the event of power failure. Design operators to be quiet in operation and function within a range 85 to 100 percent input power potential.

    a. Valves used on main air handling units shall be equipped with some sort of positioning device or system to allow manual positioning without the need for controller power. The intention of this section is to provide for continued operation of an AHU during control system servicing.
    b. Valves used in steam applications shall operate normally under extreme heat conditions (in excess of 300° F) with no external fan or air movement required.

2. Electric Actuators: Provide hydraulic or gear type electric actuators.

    a. When operated at rated voltage each actuator shall deliver the torque required for continuous uniform movement of the control device from limit to limit.
    b. Provide an integral end switch to limit travel and design the actuator to continuously stroke without damage.
    c. Operators shall function properly within a range of 85 to 120 percent of line voltage. For actuators with input power greater than 100 watts, gears shall be ground steel, oil immersed, shaft shall be hardened steel running in bronze, copper alloy or ball bearing and operator and gear trains shall be totally enclosed in dustproof cast iron, cast steel or cast aluminum housing.
    d. Actuators with input power less than 100 watts may use fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings and pressed steel enclosures.
    e. Two position actuators shall be of the single direction, spring return or reversing type.
    f. Proportioning operators shall be capable of stopping at all points in the cycle and starting in either direction from any point.
    g. Reversing and proportioning operators shall have limit switches to limit travel in either direction.
    h. Electric valve operators shall be equipped with a spring yield device to maintain control pressure on the valve disk when the actuator is in a relaxed position.
    i. For actuators with greater than 400 watts input, provide totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

3. Damper Operator Mounting: Mount damper operators where accessible for maintenance.

    a. If located outside the duct or casing, mount operators on a 14 gauge reinforced support plate arranged to allow insulation between the support plate and the face of the duct or casing.
    b. Brace damper operators rigid to show no deflection or movement over the full range of the damper stroke.

I. Differential Pressure Switches (Hydronic)

1. Differential Pressure (DP) Water Flow Switches: Switches shall be double bellows type differential pressure switches with brass bellows directly actuating a snap-acting DPDT switch. Switches shall have visible set point adjusters. Switches exposed to weather shall be weatherproof. Switch ranges and set points shall be appropriate to the manufacturer's recommendations for the pressure at the point of application and the differential pressure being monitored.

J. Current Sensing Relays

1. Relays shall monitor AC current of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for switching controller DC current as required. The set point of the contact operation shall be field adjustable.

K. Static Pressure Safety Switch

1. Air pressure switch shall be manually reset type, designed to sense static pressure and break an electrical circuit when the setpoint is exceeded. The setpoint shall be adjustable form 0.4" to 12" W.C. Unit shall be furnished and installed with a static pressure tip.

L. Duct Static Pressure Probes

1. Provide at each location indicated a duct static pressure probe capable of continuous monitoring of air static pressure. Each probe shall contain multiple static pressure pick-up points along the exterior surface of the cylindrical probe, internally connected to the averaging manifold. The station shall produce no measurable system pressure drop.
2. Each probe shall be constructed of extruded aluminum with threaded end support rod and nut and mounting plate gasket.
3. The probe shall produce a non-pulsating signal with a total accuracy of 0.5 percent of the total span.

M. Building Static Pressure Probes

1. Outside air static pressure probe shall be constructed of 10 gauge, anodized aluminum with a 2" diameter FPT connection. The probe shall be capable of sensing the outside atmospheric air pressure to within 2 percent of the actual value when subject to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.
2. Indoor static air probes shall be provided for each indoor air pressure measurement location. They shall be flush mounted with a concealed connection. They shall be constructed of 10 gage aluminum with a 1/8" coupling for output signal connection.

N. Chilled Water Meters

1. Chilled water meters shall be provided where shown on the Drawings.
2. Chilled water meters shall have a maximum operating pressure of 150 psig. Onicon Model F-1110 flow meter with BTU computation circuit and supply and return temperature sensors. Flow meter and temperature sensors shall be installed with ball valve for hot insertion. BTU meter shall have LCD display for BTU flow rate and flow totalization. Consult project engineer to determine proper pipe sizing and flow meter sizing. Flow meter shall be furnished with a BACnet communications interface.
3. A minimum of 5’ clearance shall be maintained in front of flow meter for maintenance.

O. Condensate Meter

1. Meter will consist of a full-bore body with encapsulated and rigidly retained set of coils. Meter will provide instantaneous and totalized flow available at local indicator or remotely through outputs. Meter shall measures flow using faraday’s law (induce voltage is directly proportional to the velocity of the conductive liquid). Meter k-factor shall be stable and not influenced by external piping or mounting orientation. Meter will have uniform magnetic field flux distribution eliminating piping straight run and flow profiling. Meter will measure fluids with conductivity greater than or equal to 5.0 us/cm2. Meter shall be equipped with electronics capable of interfacing with an energy management system with pulse output to be connected to Wages box. Mfg shall be cadillac, no other substitution allowed. Model: CMAG-B-11-F-150-S-S–FM.

2.3 STANDARD AUTOMATIC VALVES

A. General: Provide factory-fabricated two-way or three-way valves with two position or modulating control actuators of the type, body material, and pressure class required for each application. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements. Valve pressure class and rating shall be selected based on maximum pressure and temperature in the piping system in which it is installed.

B. Performance: All valves shall conform to the following minimum standards and selection requirements.

1. Valves shall be guaranteed to have bubble-tight shut off.
2. Provide heavy-duty actuators, with proper close-off rating for each individual application.
3. The valve assembly shall be suitable for throttling control and for tight shut-off against pump shut-off head. All valves shall be certified by an authorized officer of the manufacturer to shut-off bubble-tight against full system pump shut-off head.
4. All valves which are operated in sequence with damper motors, control switches, or other valves shall sequence properly without overlap. Provide positive positioners, oversized operators, or balanced trim if required for proper sequence control.
5. Valve schedules submitted for review shall clearly show shift in operator span for all valves operated in sequence and shut-off capability for all valves.
6. Valves for steam service shall be of globe style and designed for high temperature service with positive shut-off at or above normal operating pressure.

C. Valve Types

1. Two-Way Valves: Provide straight through pattern-type, union globe valves. Valves 1/2" to 2" in size shall have bronze, brass, stainless steel or approved corrosion resistant bodies and screwed ends. Valves 2-1/2" and larger shall have high-tensile cast iron or cast steel bodies, bronze stainless steel or approved corrosion resistant seats and trim and flanged ends. All valve stems shall be 316 or 416 stainless steel. Valves shall be designed to provide equal percentage flow characteristics at constant pressures with a rangeability of 300 to one. Low-pressure valves shall be provided with a renewable composition disc compound that will ensure tight seating.
2. Three-way Valves: Provide three-way mixing type valves. Valves 1/2" to 2" in size shall have bronze, brass, stainless steel, or approved corrosion resistant brass bodies and screwed ends. Valves 2-1/2" and larger shall have high-tensile cast iron or cast steel bodies, bronze, stainless steel or approved corrosion resistant seats and integral trim and flanged ends. All valve stems shall be 316 or 416 stainless steel. Valves shall provide constant system flow rate at all operating conditions. Provide positive positioners, oversized operators, or balanced trim if required for proper sequence controls.
3. Butterfly Valves: Where indicated on the Drawings or required by the Sequence of Operations, utilize full lug butterfly-type control valves rated for the same operating pressure as the piping system in which such valves are installed. Valves shall have bubbletight shut-off against either side of the valve when the flange is removed from the opposite side. Provide positive positioners or oversized operators if required for proper sequence control.
4. Differential Bypass Valves: Valves for control of differential bypass systems shall be of industrial quality with minimum 50:1 rangeability, equal percentage characteristics, cast iron body, 316 stainless steel trim, position indicator, heavy duty operator, stainless steel

stem, Teflon spring-loaded packed. All working parts (trim) of the valve shall be replaceable without removing the valve body from the line.

5. Small Valves: Small (one inch (1") and smaller) heating hot water and chilled water valves shall be of the three-way or straight-through equal-percentage type with polished stainless steel stems, spring-loaded Teflon or rubber packing to allow the valve to be repacked.

D. Modulating Control Operators: Provide all modulating control valves 2" and larger and all sizes of butterfly valves with a positive positioning power device. Such device shall operate independently of valve spring range or stem friction to ensure the repetition of valve position when related to the same signal increment value of controller output. Positioner sensitivity shall be sufficient to produce a stem travel reversal loss not exceeding 7% of the controller output range as it goes from its full to no-load position within its proportional band operation. Provide positioners whenever required to obtain close-off ratings or proper sequencing of valves with damper operators, relays or other valves.

E. Fail Position: Chilled water valve fail positions shall be as determined by design. Steam valves shall fail closed.

F. Valve Selection: All valves shall be suitable for the maximum design pressure and temperature of the system in which they are installed.

1. Valves shall be selected to provide tight-closing shut-off without chatter against the maximum pressure which can be encountered in the system in which they are installed.
2. Modulating valves shall be sized for fully modulating operation.
3. Two position valves shall be full line size with properly sized internal passages.
4. Water valves shall be sized with a minimum pressure drop equal to the pressure drop of the coil or heat exchanger served. Relief and bypass valves shall be sized according to the pressure available.
5. Properly sized temperature and pressure relief valves shall be installed in all hot water systems and shall be piped to the nearest floor drain per state and/or local code.
6. Properly sized steam pressure relief valves shall vent to atmosphere. A trip-stop valve is acceptable where venting to atmosphere is impossible or impractical.

G. Pressure-Independent Ball Valves with Coil Optimization Technology (Energy Valves):

1. Performance:

a. Pressure Rating for 6” and smaller: 360 psig
b. Pressure Rating for 2 ½” through 6”: ANSI 125, Class B.
c. Close-off pressure for 2” and smaller: 200 psi.
d. Close-off pressure for 2 ½” through 6”: 100 psig.
e. Process Temperature Range: Between 14 deg F to 212 deg F.

2. Flow Meter and Temperature Sensors: A characterized control valve shall be integrated with an electronic (ultrasonic or electromagnetic) wet calibrated flow sensor (accuracy +/- 2%) providing analog flow feedback, and two temperature sensors providing feedback of coil inlet and outlet water temperatures. The valves shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential range of 1 to 50 psig. Software shall control the valve to avoid the coil differential temperature from falling below a programmed set point.

3. Coil Optimization: Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Real-time data and configuration of valve operating parameters shall be available by means of BTL listed BACnet MS/TP, BACnet/IP, MODBUS or HTTP. Monitored points shall include inlet and outlet coil water temperatures, absolute flow, absolute valve position, absolute coil power and total heating/cooling energy in BTU/hr. Configuration points shall include valve, flow and power settings. Historical trend data shall be stored for up to 13 months and be retrievable in a standard time-stamped format.
4. Glycol Monitoring for 2" and Smaller: The control valve assembly shall incorporate a algorithm to automatically calculate the glycol concentration and be readable by a local device or via BACnet.
5. Body: Forged brass, nickel plated, and with threaded ends.
6. End Connection 2" and Smaller NPT female ends.
7. End Connection 2 ½" through 6" pattern to mate with ANSI 125 flange.
8. Ball: Stainless steel.
9. Stem and Stem Extension: Stainless steel, blowout-proof design.
10. Ball Seats: Teflon PTFE.
11. Stem Seal: Dual EPDM O-rings (lubricated).
12. Flow Characteristic: Equal percentage.

2.4 WIRING

A. All wiring shall conform to the requirements of the NFPA 70 and Div 26 specifications. All control, power, and communication wiring of all voltages, including wiring in mechanical rooms or when exposed, shall be run in minimum 1/2-inch EMT. Control and power cables are NOT to be placed in the same conduit with communication cables.

B. Wiring:

1. All wiring used must comply in every detail to wiring standards as set forth by the system and/or device manufacturer.
2. Wire for low voltage AC shall be minimum 300 volt insulated copper No. 18 AWG or larger conforming to NFPA 70, Type MTW, THHN, or TFFN.
3. Cables carrying analog signals shall be shielded.
4. Cables shall be terminated in solder or screw type terminal strips.
5. Cables shall not be tapped at any intermediate points.
6. All wire shall be color coded or numbered for identification. Identify as indicated on shop drawings and "As-Built" drawings. Cables and conductors shall be tagged at both ends with the identifier shown on the shop drawings.
7. Wire terminating in screw type terminal strips shall have pressure connectors conforming to UL 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors, or UL 486B, "Wire Connectors for Use with Aluminum Conductors."
8. Wire terminations without connectors or traveling pressure pads will not be accepted.

2.5 LABORATORY CONTROL SYSTEM

A. An EMS laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates

necessary to maintain temperature control, achieve minimum ventilation rates and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). The laboratory airflow control system shall operate as a system integrated with the EMS including all graphical representation at the operator workstation.

B. The laboratory airflow control system shall interface through an industry standard BACnet protocol with the specified Environmental Management System (EMS) using Ethernet and/or TCP/IP at 100 mbps. The following points shall be made available to the EMS for each laboratory as a minimum:

1. Individual valve flow and set point.
2. Total zone supply.
3. Total zone exhaust.
4. Volumetric offset and set point.
5. Space temperature, setpoint, and valve signal.
6. Occupied and unoccupied ventilation flow (if used).
7. Occupancy mode and status (if used).
8. User defined inputs.

C. Laboratory Airflow Control System - General

1. The plans and specifications for the laboratory airflow control system and the sizing of the fume hood, including the air delivery and exhaust systems and heating and cooling capacities, are based on systems and equipment as manufactured by Accutrol Controls. All controllers, sensors, and air valves shall be made by the same manufacturer for a complete, tested, proven, and functioning system.
2. The laboratory airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001:2000.
3. Monitor supply and exhaust airflow volume to each laboratory. Air flow setpoints shall be manually adjustable from the building EMS.
4. Warranty shall commence upon the date of shipment and extend for a period of 36 months, whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the owner.

D. System Performance Requirements

1. The laboratory airflow control system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood's exhaust airflow to maintain a constant face velocity over a minimum range of 20% to 100% of sash travel. The corresponding minimum hood exhaust flow turndown ratio shall be 5 to 1.
2. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/undershoot) of required airflow. Rate of sash movement shall be from one to one and one-half feet per second.
3. The laboratory airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions, such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems

using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.

E. Motorized Airflow Valves

1. The Airflow Control Valve shall be a multichamber AccuValve® (Model AV3000) / AccuValve® with ePI™ (Model AVC).

   a. The Airflow Control Valve (Model AV3000) shall consist of a compression section, two airflow control surfaces, factory-mounted digital vortex airflow measuring device factory-mounted high speed electric actuator and integral access panel.
   b. The Airflow Control Valve (Model AVC) shall consist of a compression section, two airflow control surfaces, factory-mounted digital vortex airflow measuring device factory-mounted high speed electric actuator, integral access panel and integrated high performance closed-loop feedback controller with native BACnet.

2. The compression section shall divide the airstream into at least two separate airstreams. Each airstream shall be approximately equal in size and the total open area shall be approximately 50% of the duct open area. The divided sections shall cause compression therefore creating a more laminar flow for better airflow measurement and turndown. The compression section shall be of an aerodynamic shape with a static regain section to insure minimal pressure drop. The valve shall not require any duct straight runs either upstream or downstream of the airflow valve to achieve required specified performance.
3. Airflow control valves shall be a linear type and shall operate with a minimum turndown ratio of 8 to 1. Accuracy of the airflow valve shall be 5% of reading in the 8 to 1 range of the damper.
4. The airflow control valve shall be capable of being mounted in any position (360º mounting plane) in ductwork without the need for recalibration. It shall not be required to specify mounting plane when ordering valve. If valve provided can only be mounted in either a horizontal or vertical plane and must be specifically ordered as such, then at least 5 extra horizontal and 5 extra vertical valves of each size and material shall be provided by the valve supplier at no extra cost to the manufacturer to avoid delays in construction, installation and certification.
5. Valve body material for non-corrosive service such as for Supply and General Exhaust shall be galvanized steel or aluminum; 20gauge (galvanized) / 16gauge (aluminum) for body and 16gauge for blades. Valve shaft material shall be 316SS.
6. Airflow control valves shall operate without linkages, springs, levers, or bearings, in the airstream due to the effect of fume hood exhaust on those materials, and shall exhibit no deadband or hysteresis. Airflow control valves shall be field selectable fail-safe to either the open or closed position depending on the application. For airflow valves with linkage, springs, levers or bearings in the airstream access doors must be provided upstream and downstream of each and every damper for inspection of those devices for maintenance purposes.
7. All critical components of the airflow control valve shall be easily accessible from one side of the valve. All linkages shall be out of the airstream to avoid possible corrosion and loss of accuracy.
8. Airflow control valves shall be of a low pressure drop design for energy efficiency. Valves shall not require greater pressure drop than listed at “Max CFM” on project valve schedule or 0.3”, whichever is less. Airflow control valves that require higher pressures to operate shall not be acceptable. The provision of a larger airflow control valve that is scheduled to

accommodate the lower scheduled pressure drop is not acceptable. Airflow control valves that require higher pressures to operate shall not be acceptable. In order to ensure the minimum operating pressure of any valve meets the specification any valve must be provided with a Minimum Operating Pressure curve as tested in accordance with ANSI/ASHRAE STD 130 Paragraph 5.3 as described in 1.1.G of this specification. Any airflow control valve that does not publish this information will not be considered for this project.

9. The airflow valve shall be complete with a digital vortex type airflow sensing device providing true airflow feedback for the system. Airflow valves using mechanical means for creating pressure independence will not be acceptable. If an airflow valve such as a venturi valve is submitted that uses mechanical means for creating pressure independence such as springs and plungers, the valve manufacturer shall provide a 5 year service contract to the owner at no additional charge.
10. Demand Based Static Pressure Reset Control (DBSPRC) – Valve must be capable of being utilized with a demand based static pressure reset control scheme as described in ASHRAE Standard 90.1-6.5.3.2.3.

    a. DBSPRC offers considerable savings in operating cost by minimizing the static pressure in the duct thereby allowing the supply and exhaust fans to operate at lower brakehorsepower. To utilize DBSPRC the airflow valve must incorporate airflow measurement and closed loop control. Through the measurement of true airflow, the valve will modulate to the proper airflow volume. This will occur regardless of the static pressure in the duct. Information on the valve postion will then be communicated to the BMS which will use that information to reset the static pressure in the duct to the minimum setpoint possible to maximize energy savings.
    b. An open loop venturi valve shall not be acceptable because it relies on a calibrated spring and plunger which only drives to a specific valve position and relies on the spring to compensate for pressure changes. Therefore valve position is not indicative of required static pressure in the system and a venturi valve cannot be used for DBSPRC.
    c. A mechanical based aiflow control valve such as a venturi valve that cannot meet the demand based static pressure reset control scheme as described in ASHRAE Standard 90.1-6.5.3.2.3 shall not be acceptable.
    d. Should a venturi valve be offered as a substitute for a low pressure drop closed loop control valve the contractor offering the valve must provide each venturi valve with a static pressure reset kit which requires duct straight runs of 3x Duct Diameter (upstream of venturi valve) and 4x Duct Diameter (downstream of venturi valve) ensuring that the pressure pickups are located such that they will not be susceptible to clogging or condensation within the tubes. The contractor substituting the venturi valve shall also be responsible for associated design change and field duct changes to accompany the requirement of straight duct run upstream and downstream of the venturi valve (see above).

11. Airflow measuring devices shall be of the Vortex Shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume. Pitot or Thermal Airflow sensors shall not be acceptable.
12. Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars. Standard materials shall be manufactured of corrosion resistant plastic.
13. Individual velocity sensors shall not be affected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the air stream.

The output from individual sensors shall be linear with respect to airflow velocity and shall be capable of sensing airflow in one direction only. The velocity sensors shall not require calibration.

14. Velocity sensing methods other than those specified shall not be acceptable. For another velocity sensing method to be considered it must provide the basic requirements for linear electronic output, turndown, accuracy, materials of construction, and output signal. If differential pressure devices are to be considered, dual differential pressure transmitters, the span of the lower transmitter being one tenth the span of the higher, with an accuracy not less than +/- 0.5%, shall be utilized to provide the required turndown. Orifice type devices shall have a Beta ratio of 0.7 or less, and shall be installed in accordance with ASME MFC-3M guidelines for up and downstream conditions.
15. The airflow sensors shall be easily accessible in the valve for inspection without removing valve from the duct.
16. Use of valve or damper position for calculation of airflow volume is not acceptable. Direct airflow measurements must be taken.
17. Sensing methods employing thermal devices in the airstream shall not be acceptable due to their susceptibility to dust and dirt buildup in and exhaust airstream which could cause serious errors in readings and resultant safety issues in the laboratory.
18. Airflow Control Valve shall have factory installed high speed electric actuator specifically adapted to the stroke of the valve which shall operate on 24VAC. Power requirement for each airflow valve actuator shall not exceed 24VA.
19. Airflow Control Valve (where required) shall have an integral closed-loop feeedback controller. Airflow measurement through the vortex airflow sensor shall send the digital signal to the controller which modulates the high speed electric actuator to maintain desired airflow setpoint. The airflow setpoint shall have the capability of being provided through analog input, digital input, communications over BACnet MS/TP or AVC internal program memory. Analog output signal shall be provided for airflow and alarm outputs must be provided to indicate abnormal airflow conditions.

    a. Power requirement for each airflow valve with integral controller shall not exceed 27VA for all single valves and 50VA for dual valves.

20. The airflow control valve shall not exceed the NC levels shown in the Table 1. NC levels are calculated based on the octave band sound attenuation factors shown in Table 2.

    a. If the airflow control device cannot meet the NC levels specified a properly sized silencer or sound attenuator must be used.
    b. All silencers must be of a packless design (constructed of at least 18 gauge 316L stainless steel when used with fume hood exhaust) with a maximum pressure drop at the device’s maximum rated flow rate not to exceed 0.20 inches of water.
    c. Due to the increased pressure requirements of a venturi valve if a venturi is submitted it must meet the NC levels specified in Table 1 with 2.0” of pressure across the valve instead of 1.0” for an dual chamber valve.

Table 1: Maximum NC Levels of Supply, Radiated and Exhaust airflow control valves

Valve Size inches	Airflow CFM	Pressure Drop (" wg)		Maximum NC Level		
		AccuValve	Venturi	Supply	Radiated	Exhaust
6	290	1.0	2.0	<20	<20	51
8	700	1.0	2.0	23	27	49
10	1000	1.0	2.0	23	22	41
12	1500	1.0	2.0	25	21	52
14	2200	1.0	2.0	22	23	51
12x18	2000	1.0	2.0	29	27	47
12x24	3000	1.0	2.0	25	26	44
12x36	4500	1.0	2.0	33	31	51
12x48	6000	1.0	2.0	29	30	47

Table 2: Octave Band Sound Attenuation Factors

Radiated Sound	Octave Band					
	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
Ceiling/Space Effect	16	18	20	26	31	36
Total dB Reduction	18	19	20	26	31	36

Discharge Sound	Octave Band					
	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
Duct Lining	2	6	12	25	29	18
End Reflection	9	5	2	0	0	0
5 ft., 8 in Flex Duct	6	10	18	20	21	12
Space Effect	5	6	7	8	9	10
Total dB Reduction	24	28	39	53	59	40

Exhaust Sound	Octave Band					
	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
Space Effect	5	6	7	8	9	10
Total dB Reduction	7	7	7	8	9	10

The following dB adjustments are used, per ARI 885-98 for the calculation of NC above 300 CFM						
	Octave Band					
	2	3	4	5	6	7
300-700 CFM	2	1	1	-2	-5	-1
Over 700 CFM	4	3	2	-2	-7	-1

F. Exhaust and Supply Airflow Device Controller

1. The airflow control device shall be a microprocessor-based design and shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow volume.
2. The airflow control device shall store its control algorithms in non-volatile, re-writeable memory. The device shall be able to stand-alone or to be networked with other room-level digital airflow control devices using an industry standard protocol.
3. Room-level control functions shall be embedded in and carried out by the airflow device controller using distributed control architecture. Critical control functions shall be implemented locally; no room-level controller shall be required.
4. The airflow control device shall use industry standard 24 Vac power.
5. The airflow control device shall have provisions to connect a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.
6. The airflow control device shall have built-in integral input/output connections that address fume hood control, temperature control, humidity control, occupancy control, emergency control, and non-network sensors switches and control devices. At a minimum, the airflow controller shall have:

    a. Universal inputs capable of accepting 0 to 10 Vdc, 4 to 20 mA, 0 to 65 K ohms, or Type 2 or Type 3 10 K ohm @ 25 degree C thermistor temperature sensors.
    b. Digital inputs capable of accepting a dry contact or logic level signal input.
    c. Analog outputs capable of developing either a 0 to 10 Vdc or 4 to 20 mA linear control signal.
    d. One Form C (SPDT) relay output capable of driving up to 1 A @ 24 Vac/Vdc.

7. The airflow control device shall meet FCC Part 15 Subpart J Class A and be UL916 listed.

G. Control Functions

1. The airflow control devices shall utilize peer-to-peer, distributed control architecture to perform room-level control functions. Master-slave control schemes shall not be acceptable. Control functions shall include, at a minimum, pressurization, temperature, humidity control, as well as respond to occupancy and emergency control commands.
2. Pressurization Control

    a. The laboratory control system shall control supply and auxiliary exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces.
    b. The pressurization control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. The offset shall be adjustable.
    c. The pressurization control algorithm shall consider both networked devices, as well as up to three non-networked devices providing a linear analog flow signal and any number of constant volume devices where the total of supply devices and the total of exhaust devices may be factored into the pressurization control algorithm.
    d. Volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as a means of control shall

provide documentation to demonstrate that space pressurization can be maintained if fume hood sashes are changed at the same time a door to the space is opened.

e. The pressurization control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply airflow control devices in order to optimize air distribution in the space.

3. Temperature Control

a. The laboratory control system shall regulate the space temperature through a combination of volumetric thermal override and control of reheat coils. The laboratory control system shall support up to four separate temperature zones for each pressurization zone. Each zone shall have provisions for monitoring up to five temperature inputs and calculating a straight-line average to be used for control purposes. Separate cooling and heating set points shall be writeable from the EMS, with the option of a local offset adjustment.

b. Temperature control shall be implemented through the use of independent primary cooling and heating control functions, as well as an auxiliary temperature control function, which may be used for either supplemental cooling or heating. Cooling shall be provided as a function of thermal override of conditioned air with both supply and exhaust airflow devices responding simultaneously so as to maintain the desired offset. Heating shall be provided through modulating control of a properly sized reheat coil. Temperature sensors shall meet the requirements of section 2.10.

c. The auxiliary temperature control function shall offer the option of either heating or cooling mode and to operate as either a standalone temperature control loop, or staged to supplement the corresponding primary temperature control loop.

4. Occupancy Control

a. The laboratory control system shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the EMS as a scheduled event or through the use of a local occupancy sensor or switch. The laboratory control system shall have a local occupancy override button that allows a user to override the occupancy mode and set the space to occupied for a predetermined interval. The override interval shall be configurable from one to 1440 minutes. The local occupancy sensor/switch or bypass button shall be given priority over a EMS command.

5. Emergency Mode Control

a. The laboratory control system shall provide a means of overriding temperature and pressurization control in response to a command indicating an emergency condition exists, and airflow control devices are to be driven to a specific flow set point. The system shall support up to four emergency control modes. The emergency control modes may be initiated either by a local contact input or EMS command.

b. Once an emergency mode is invoked, pressurization and temperature control are overridden for the period that the mode is active. Emergency modes shall have a priority scheme allowing a more critical mode to override a previously set condition.

6. Local Alarm Control

    a. The laboratory control system shall provide the means of summing selective alarm activity at the room-level network and generating a local alarm signal. The local alarm signal may be directed to any available output, as well as to the EMS. The alarm mask may be configured differently for each room-level system.

7. Diversity Alarm

    a. The laboratory control system shall have the ability of monitoring the airflow values for the pressurized space and generating an alarm signal in the event the total exhaust flow exceeds a predetermined threshold. The diversity alarm is intended to allow the user to take diversity in the design and generate an alarm condition in the event the diversity threshold is compromised. This function must be available in either an integrated or standalone system.

H. Room Pressure Monitors

1. The room pressure monitor shall measure differential pressure between two spaces using industrial grade differential pressure transducers. Indirect flow measurement using thermal anemometer shall not be acceptable.
2. The monitor panel shall display the differential pressure using a LCD multicolor display. Local visual and audible alarm with a silence switch shall be provided.
3. Selections and adjustments that may be made at the jobsite shall include positive or negative pressurization mode, alarm setpoints, and a 1 to 30 second alarm activation delay.
4. The monitor shall have an accuracy of +/-0.5% F.S., hysteresis of +/-0.05%, linearity of +/-0.4%, repeatability of +/-0.1%, and response time of greater than 0.25 seconds for full span input.
5. The monitor shall be integrated into the FMS for pressure values and alarms through a BACnet communications connection.

PART 3 - EXECUTION

3.1 FIELD DEVICE INSTALLATION

A. Space temperature transmitters shall be installed 60" A.F.F. If a setpoint adjustment is provided on the sensor then the unit shall be installed 48" A.F.F. unless otherwise specified on the plans.

B. All temperature sensors installed in liquid lines, tanks, etc., shall be installed in stainless steel thermowells. The thermowells shall be supplied to the mechanical contractor for installation under other Sections of the Specification. A thermo-conductive paste shall be applied between the sensing element and the thermowell.

C. Outdoor air temperature elements shall be installed in a location that is continuously shaded and not effected by heat generating equipment or equipment intakes or discharges. The element shall be installed under a sun shield and high enough to avoid damage from vandalism.

D. Duct point temperature elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent

any air leakage. Care must be taken to avoid direct contact between the temperature element and any heat transfer surface such as a coil.

E. Duct averaging elements shall be installed with the same requirements as for the temperature point elements; however; the averaging elements shall be extended across the entire duct area in a zigzag pattern covering the entire surface area. Special clips shall be used to secure the elements at turns to prevent chafing of the elements. Where elements pass through a duct plastic tubing or similar protection shall be installed on the elements to prevent damage to the elements from vibration.

F. Duct static pressure stations so that the direction of flow is observed when installing the probe to prevent measurement of total pressure. The connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Connections from the "HI" pressure port to the differential pressure transducer shall be 1/4" plastic tubing which shall not extend for more than ten feet. Pressure stations shall be installed 2/3 the distance down the duct of all major branch ducts or as indicated on the Drawings.

G. All air differential pressure transmitters shall be installed within ten feet of the pressure sensing point. The transmitters shall be installed in a NEMA 1 housing for interior conditioned spaces and in NEMA 3R housings for outside or unconditioned spaces. The transmitters and housings shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. Access to the transmitter shall be provided.

H. Outdoor humidity transmitters shall be installed in a location not affected by equipments that might generate humidity or temperature effects. The transmitter shall be installed where direct moisture (rain) cannot contact the device.

I. Duct point humidity elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. The sensing element shall be located at least ten feet downstream of any coil, humidifier, or dehumidifier.

J. Space humidity transmitters shall be installed at 60" A.F.F. If a setpoint adjustment is provided on the unit the unit shall be installed at 48" A.F.F. unless otherwise specified on the plans.

K. Current switches shall be installed in one leg of three phase circuits and the hot leg of single phase circuits and in all cases, after the local disconnect. The switches shall be adjusted to close at approximately 10% of the attached loads full load amps.

L. Low limit thermostats shall be installed with the averaging element extended across the entire duct area in a zigzag pattern. Special clips shall be used to secure the element at turns to prevent chafing of the element. If an element passes through a duct, plastic tubing or similar protection shall be installed on the element to prevent damage to the element from vibration. The thermostat setpoint shall be set as indicated and the circuit shall be tested to ensure actions as required.

M. All liquid differential pressure transmitters shall be installed within ten feet of the pressure sensing points. The transmitter shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. The piping for the sensing points shall include isolation valves such that the transmitter can be removed without having to shut down the liquid system. Access to the transmitter shall be provided.

N. Outside air static pressure probes must be installed and piped according to manufacturer's instructions to ensure accuracy of the static pressure reading and eliminate the effects of condensation in the sensing lines. Coordinate installation of probes with the necessary trades for proper sealing of all roof penetrations.

O. Air differential pressure switches shall be connected to pitot tube pickup probes pointing into the air stream on both sides of the process variable. Connections between the switch and the pitot tubes shall be 1/4" hard copper.

3.2 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Comply with all Division 26 installation requirements. All control, power, and communications wiring shall be installed in conduit.

B. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

C. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

D. All wire-to-device connections shall be made at terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

E. Plug or cap all unused conduit openings and stubups. Do not use caulking compound.

F. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

G. Set conduits as follows:

H. Expanding silicone firestop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.

I. Oakum and lead, sealed watertight penetration through outside foundation walls.

J. Cap open ends of conduits until conductors are installed.

K. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18" and maximum length of 36" shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

L. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

M. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

3.3 LABORATORY CONTROL SYSTEM

A. The contractor shall install all routers and repeaters in an accessible location in or around the designated laboratory room.

B. The contractor shall install appropriately sized and fused 24 Vac transformers suitable for NEC Class II wiring.

C. All wire and cable shall be furnished and installed by the contractor. The contractor shall terminate and connect all cables as required. The contractor shall utilize wire and cables specifically recommended by the laboratory airflow controls supplier. The contractor shall provide power for all devices not specified in Div 26.

D. The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.

E. The mechanical contractor shall provide and install all reheat coils and transitions.

F. The mechanical contractor shall provide and install insulation as required.

G. The mechanical contractor shall provide and install all flange gasket material required.

H. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

I. System start-up shall be provided by a factory-authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment, as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust or return), system programming and integration to EMS.

J. The balancing contractor shall be responsible for final verification and reporting of all airflows.

K. System start-up includes a demonstration that all the laboratory airflow performance requirements of the specification are met. The Laboratory Controls System Manufacturer provides a visual demonstration that the laboratory airflow systems are maintaining specified hood containment performance requirements. If the performance requirements cannot be demonstrated, then the Laboratory Controls System Manufacturer is responsible for any costs and labor necessary to meet the minimum performance requirements.

L. The Laboratory Controls System Manufacturer demonstrates that with the specified room offset, the systems are maintaining the proper room pressurization polarity under both static conditions and can recover to the proper polarity within one second of a change in room/system conditions. Verification is provided by a permanent or temporary visual indication, i.e., smoke wand or streamers taped to the undercut of the door. If the performance requirements cannot be demonstrated, then the Laboratory Controls System Manufacturer is responsible for any costs and labor necessary to meet the minimum performance requirements.

M. The laboratory airflow control system supplier shall furnish a minimum of eight (8) hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor

calibration, general procedures for verifying airflows of air valves and general troubleshooting procedures.

N. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

O. Another four (4) hours of operator training shall be provided for the personnel actually working with the hoods. This is to include emergency procedures as well as normal operating procedures.

P. All software and connection cables required to access and adjust all laboratory, air valve, and fumehood controllers shall be furnished to the contractor and to the owner so field adjustments can be made to the system by qualified technicians.

END OF SECTION 25 3500

SECTION 25 5000 - ENVIRONMENTAL MANAGEMENT SYSTEM (BACNET PROTOCOL)

PART 1 - GENERAL

1.1 OVERVIEW

A. The Scope of Work described in this Section and as shown on the Control Drawings shall be provided and installed under this Section of the Specification.

B. This document contains the specification for development of the Environmental Management System (EMS) at New Mexico State University. At the building level the EMS system architecture utilizes intelligent distributed control modules located in each building which communicate using BACnet/IP (preferred) over Ethernet or BACnet MS/TP over EIA-485 Local Building Automation Networks. A given building commonly contains several such Local Building Automation Networks. A typical single network might serve all the terminal units on a single floor of the building. Another typical network might serve the various pumps, valves, VFDs, etc., making up the central mechanical system of a building.

C. The Local Building Automation Networks communicate with each other and the university central monitoring and control system primarily through owner-provided Tridium Niagara AX Network Area Controllers (NAC). These are BACnet Building Controller (B-BC) devices which provide standard BACnet router and BBMD functions as well as BACnet/IP and MS/TP (master) connectivity. They also provide connectivity to the Owner's central monitoring and control system. (The PICS information for these devices is available upon request to the Owner's Environmental Systems Department.) All Local Building Automation Networks must be designed, configured, and installed for successful operation in this environment. The Local Building Automation Networks are private networks internal to the university and are not accessible for remote connections. All activities which require network connections (including but not limited to commissioning or maintenance) must be accomplished by the use of direct on-site physical connections. Any contractor or vendor equipment to be used on these networks must be registered in advance with the Owner's Environmental Systems Department.

D. All normal operational user interface and Operator Workstation capabilities are provided by the Owner as part of the Owner's central monitoring and control system. The use of web interfaces is encouraged for purposes such as device configuration and any supplementary vendor-supplied graphic displays.

E. The equipment connected on each Local Building Automation Network shall be designed, configured, and installed so as to maintain stable and safe operation of the equipment in the event of any failure of network communication with any other Local Building Automation Network or the university central system. If it is necessary that data be exchanged between equipment on different Local Building Automation Networks even while normal network connections through a NAC are disrupted then such interconnections shall be accomplished using hard-wired I/O points.

F. All installed equipment must be fully compliant with ANSI/ASHRAE Standard 135-2004 (BACnet) and all published addenda at the time of installation. No gateways, non-compliant, or

proprietary equipment or communication techniques of any kind are to be used on the Local Building Automation Networks.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 23 05 00, Common Work Requirements.

B. Section 23 05 05, Piping Specialties.

C. Section 23 05 23, Valves.

D. Section 23 05 49, HVAC and Electrical Installation Coordination.

E. Section 23 05 50, Variable Frequency Drives.

F. Section 23 05 93, Testing, Adjusting and Balancing.

G. Section 23 08 00, Commissioning.

H. Section 25 35 00, Controls – Field Devices

1.3 SCOPE

A. It is the intent of this Section to provide, install, connect, program, and calibrate the additions and/or modifications to the EMS as necessary to provide fully automatic control for all systems as shown in the Control Drawings, stated in the sequences of operation, indicated in the electrical ladder diagrams, or as otherwise required by the Contract Documents. Some equipment controls are specified to be provided in other portions of the Contract Documents, including Owner-furnished equipment. As work of this Section, coordinate with these other suppliers and trades to provide a complete and fully functional EMS.

B. It is the responsibility of the bidder to read and conform to all Sections of the Specifications, review all Contract Drawings of all divisions, and coordinate with all equipment suppliers of material specified under other Sections of the Specifications.

C. The engineering, installation supervision, programming, calibration, startup, and checkout necessary for a complete and fully operational EMS, as specified hereafter, shall be provided under this Section.

D. Provide training and instruction of the installed EMS.

E. Provide the necessary materials and manpower to participate in the testing, adjusting, and balance and the commissioning process as required by those Sections of the Specifications.

1.4 SUPPLIER AND EQUIPMENT REQUIREMENTS

A. EMS Supplier will be the authorized factory representative or branch office of the product manufacturer proposed. All software and hardware products shall be BACnet compatible to the level specified. (See also the Interface Specification submittal requirements of Section 1.5 B.

4.) No deviation from these requirements will be permitted.

B. The EMS contractor must be listed under the Owner's BACnet Pre-Qualification program, which includes specification of acceptable building automation devices. The firm used for this project shall be:

1. PC Automated Controls – El Paso, TX

1.5 SUBMITTALS

A. Within thirty (30) days of Contract award, submit six (6) sets of Shop Drawings and Submittal Data in accordance with the General Contract Requirements and Submittal Requirements of this Section.

B. Submittals shall consist of Shop Drawings, Catalog Data Sheets, Graphic Displays, and Software Development parameters as defined in the following paragraphs. No materials shall be purchased and no work shall be conducted at the job site until submittals have been reviewed and approved by the Owner.

1. Shop Drawings shall be provided which show detailed communications architectures (including the existing communication network), control devices, electrical ladder diagrams, control system schematics, Protocol Implementation Conformance Statements (PICS), sequences of operation, point lists (see section 1.5. B. 4.), and a material list. All systems and the associated control components as well as all connections between components shall be clearly indicated. The submittal shall indicate the required coordination with equipment supplied by sources other than this Section. The intention is for the Shop Drawings to be comprehensive enough for the installation crew to complete all aspects of the installation without the need for supporting documentation, except third-party equipment installation manuals. All wiring shown on the Drawings shall be labeled on both ends and these labels shall be used in the installation process for ease of comparing the Shop Drawings to the actual field installation. Each control component shall be given a unique identifier. This identifier shall be used in creating equipment field device labels and in the Sequence of Operation so that reference to the Drawings can be easily referenced.

   a. Electrical Ladder Diagrams shall be shown on the Shop Drawings. Electrical Ladder Diagrams shall show the specific details of all switches, relays, motor starters, etc. The Electrical Ladder Diagrams shall show the correct control wiring and interlock wiring of all equipment provided under the Contract. Each diagram shall reference the correct power source by breaker panel and circuit number.
   b. The Sequence of Operation for each controlled system shall be provided with reference to the control device identifier. The Sequence of Operation shall break down the control operation by major function (e.g., mixed air control, occupied-unoccupied, smoke purge, etc.) and describe in detail the correct operation and interaction with other system functions. Use of the Sequences of Operation stated on the Contract Control Drawings is acceptable; however, they shall be modified to reflect actual control device identifiers.
   c. A complete Material List shall be included on the Shop Drawings which show the device model numbers, control device identifiers, quantities, manufacturers, etc., of all equipment provided under this Section. The Material List shall be organized in alphabetical order so that it can be easily compared to the associated Catalog

Data Sheets.

2. Catalog Data Sheets will be provided for each different piece of equipment provided under this Section. At a minimum the Data Sheet shall contain sufficient information so that compliance with the Specification can be verified. Where multiple models or options are indicated on the same Catalog Data Sheet, the equipment proposed shall be highlighted or otherwise indicated. The Catalog Data Sheets shall be organized in alphabetical order to match the Material List on the Shop Drawings.
3. Point Verification forms shall be submitted for all points that will be installed as part of the EMS. Once approved, the Contractor shall complete the forms during startup to document successful point functionality. The completed forms shall be included as part of the record documentation. The Owner reserves the right to designate a representative to monitor completion of the Point Verification.
4. An Interface Specification shall be submitted as a Microsoft Excel spreadsheet describing each Local Building Automation Network including its BACnet network number, the complete list of devices to be placed on each such network, the BACnet Device Object instance number for each device, the BACnet object names and identifiers to be used within each device including identification of those objects for which commissioning trend logs will be provided, the MAC addresses of MS/TP devices, and all BACnet object cross-references between the devices on the complete set of Local Building Automation Networks . (A sample spreadsheet in the required format will be provided upon request to the Owner's Environmental System Department.) The BACnet network numbers and Device Object instance numbers must be selected from ranges requested by the Contractor from the Owner's Environmental Systems Department. The object names must have a <facility>.<system>.<point> structure such as "GARDINER.AHU_1.MA_TEMP",or"GARDINER.BASEMENT_MER.AHU_1.CW.STEMP" where the <facility> term must always be "GARDINER". The Interface Specification must be accompanied by a Microsoft Word or Adobe PDF document presenting the Protocol Implementation Conformance Statements (PICS) for all devices to be provided. No automation devices are to be installed prior to approval of the Interface Specification's complete contents by the Owner's Environmental Systems Department. The Interface Specification must include the MAC address for each Ethernet device. The Owner's Environmental Systems Department will then provide the IP address to be used for each of the devices.
5. If any graphics software is necessary (to provide capabilities beyond those which are provided by the Owner's central system) then all Graphic Slides (or typical graphics for identical equipment) proposed for use on this Project shall be submitted for review and approval. The submitted slides shall be printed in color. All realtime display fields, user input fields, etc., shall be clearly indicated. No graphic software shall be installed on the job site until the Graphic Slides have been approved.
6. Software Development parameters including all trend logs, reports, point alarm parameters, passwords, and scheduling shall be submitted based on the contents of this Specification Section. The information contained in this portion of the submittal will be followed during development of the programming code and shall be used for evaluation of the system's performance during the commissioning phase.

    a. Report templates shall indicate what information will be presented on each report, how the information will be presented, report hard disk upload parameters, and report log file names.
    b. If user authentication is required in any part of the installed system blank forms shall be submitted for completion of user information by the Owner. The forms

shall allow the Owner to fill in the operator's name and approved password level. During Owner training, the EMS programmers shall coordinate with the approved operators to allow the operators to input their private passwords.

c. Blank schedule forms for each air handling unit shall be submitted for completion by the Owner. Additionally, a blank schedule group form template shall be submitted so the Owner can identify schedule groups of HVAC equipment.

7. The names, phone numbers, e-mail addresses, job descriptions, pager numbers, mobile phone numbers, etc., shall be provided for the project manager, project engineer, project programmer(s), installation foreman, and any other individuals key to the completion of this project. If at any time during the project the assignment of personnel changes, the Owner and the Engineer shall be notified and the previously listed information shall be furnished for the newly assigned individuals.

1.6 RECORD DRAWINGS

A. Record Drawings shall be provided as required by the general Contract Requirements. Record Drawings shall not be completed until after installation is complete. Any changes made during installation shall be recorded on the Contractor's master record drawings as the changes are made so that a current Record Drawing is constantly being updated. These As-built Drawings shall be available at all times for inspection by the Owner, Engineer, or Owner's Representative. At completion of the Project, all hand-drawn field changes shall be incorporated into a clean reproducible set of As-built Drawings. These As-built Drawings shall be used during the training sessions.

B. The Contractor shall furnish a complete spare parts lists, operating instructions, maintenance literature, and completed point verification forms.

C. Record drawings shall be provided electronically and shall be directly editable using Autodesk AutoCAD 2008. Non-drawing project data shall be provided electronically as editable Microsoft Office 2003 documents.

D. After final occupancy and all debugging have occurred, the Contractor shall deliver to the Owner all project-specific control software programs in an electronic format acceptable to the Owner; and all software used or needed to program, configure, install, commission, expand, or maintain any element or aspect of the installed system. All software packages must be permanently licensed in the name of the Owner and include full no-added-charge support by the manufacturer for the duration of the project warranty period.

1.7 SYSTEM TESTING

A. At the termination of the point verification process, the Contractor shall submit completed and approved Point Verification forms for each point.

B. Upon successful completion of all Point Verification testing, the Contractor shall submit hard copies of the Trend Logs called out in the approved Interface Specification (see section 1.5. B. 4.). The Trend Logs shall trend at least 48 hours of normal uninterrupted operation (non-weekend or holiday) for the purpose of documenting proper implementation of the control sequences of operation.

C. The Owner reserves the right to participate in or assign a representative to participate in the startup, testing, programming, or any other aspect of the construction of this project at no additional cost to the Owner.

1.8 TRAINING

A. A total of eighty (80) hours of training time shall be provided by the Contractor.

B. During the initial startup phase of the project, the EMS Supplier shall permit the Owner's operating personnel to be involved with the troubleshooting, initial startup, point verification testing, and performance trending.

C. Prior to the final system trending, the Contractor shall provide three (3) days (20 hours) of training for up to six (6) Owner-designated operating personnel. The training shall cover all general aspects of the EMS system installation, wiring, calibration techniques, programming, troubleshooting, etc. The training shall not cover the details of this specific project. The training shall provide the same structure and depth as that provided to factory-authorized representative's installation and programming personnel.

D. Upon completion and acceptance of the Work, provide three (3) days (20 hours) of training for up to six (6) Owner-designated operating personnel who have responsibility for the mechanical/control system. This training shall be conducted on site and shall focus on the specifics of this Project. A complete training booklet shall be provided and used during the training period. The booklet shall include the As-built Drawings.

E. The EMS Supplier shall provide 40 additional hours of on-site training during the warranty period. The Contractor shall provide this training at the request of the Owner. The Owner will give at least one-week notice of the need for additional training. Warranty and service time shall not constitute training hours.

1.9 SERVICE AND WARRANTY

A. The system supplier shall maintain a maintenance support facility complete with system technicians, diagnostic and test equipment, and new spare components. Emergency service shall be available in the local office on a 24-hour, 7-day a week basis. The service agent shall provide a continuously monitored local service telephone number for emergency service.

B. Service and maintenance must be provided for one (1) year from time of Owner acceptance of the control system. If the manufacturer has a standard warranty that exceeds the specified requirement then the longer manufacturers warranty shall be provided to the Owner. Service during this period shall be available within 12 hours from the time the trouble call is placed. Warranty shall be for all materials and labor provided as the Scope of Work of this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products shall be selected in accordance with Part 2 of this Section. Installation of the

components shall be in accordance with Part 3 of this Section.

2.2 NETWORKING/COMMUNICATIONS

A. Campus Local Area Network

1. The Owner's Campus Local Area Network shall be used for interconnecting the Local Building Automation Networks and the Owner's central monitoring and control system.
2. The Campus Local Area Network shall be extended as required by the Contract drawings and specifications.

B. Local Building Automation Networks

1. All BACnet controllers shall reside on a Local Building Automation Network. The Owner's Network Area Controllers are used for intercommunication between the Local Building Automation Networks, and between the Local Building Automation Networks and the Owner's central monitoring and control system.
2. Development of the Local Building Automation Networks is work provided entirely under this Section of the Specification.
3. All devices that reside on a Local Building Automation Network shall communicate in native BACnet. Proprietary protocols will not be permitted.
4. The Owner's preference is that no more than 35 BACnet devices shall be placed on a single Local Building Automation Network. Approval will not be given for more than 60 BACnet devices on a single Local Building Automation Network network.

2.3 BACnet COMPATIBILITY

A. All controller devices supplied to meet the functional and operational requirements of this specification shall conform, at a minimum, to one of the BACnet device profiles contained in BACnet, Annex L:

1. BACnet Building Controller (B-BC), or
2. BACnet Advanced Application Controller (B-AAC) or
3. BACnet Application Specific Controller (B-ASC).

B. The interoperability requirements of such devices are contained in Annex L of the BACnet standard. B-BC controller devices shall communicate using BACnet/IP. BACnet/IP is also preferred for other devices, but BACnet over MS/TP at 78.4 Kbps is acceptable. ARCNET at 156 Kbps is acceptable but only when accessed via a BACnet/IP router. No other protocols or techniques are acceptable.

2.4 INPUT/OUTPUT AND INTERLOCK WIRING

A. Class I Circuits

1. All materials required for installation of Class I circuits or circuits operating at greater than 48 VAC or VDC shall meet the requirements stated in Division 16, National Electric Code, and all applicable building codes as they apply to Class I circuits.

B. Class II Circuits

1. All materials required for installation of Class II circuits shall meet all requirements of the National Electric Code and all applicable building codes as they apply to Class II circuits.
2. All cables shall be run in dedicated conduit no smaller than ¾" or a metallic raceway and shall contain conductors per the manufacturer's recommendation for the application. The number of conductors shall be as required by the application and an overall foil shield with stranded drain wire shall be provided in all cases. The cable shall be factory stamped with a clear indication of the cable classification. The cable jacket shall be PVC. Metallic raceway and conduit shall be as specified in Division 16.
3. Local Building Automation Network cables shall be in dedicated conduit containing no other signal or power wiring.

PART 3 - EXECUTION

3.1 GENERAL

A. All field hardware, control devices, conduit, wiring, etc., shall be provided as specified in Part 2 of this section and in Section 253500.

1. The installation all aspects of the system shall comply with all applicable codes, regulations, and all related Contract Documents.
2. The installation of all materials shall be in accordance with the published manufacturer recommendations without exception. If for some reason a particular component cannot be installed in compliance with these recommendations, the Contractor shall advise the Engineer of the situation.
3. Where miscellaneous materials are required to complete an installation, i.e., isolation valves for pressure switches, wall switches for an exhaust fan control circuit, etc., the materials shall be supplied as defined in the relevant Section of these Specifications and installed under this Section of the Specification, unless otherwise noted.
4. Coordinate with other trades where installation of a particular component requires other trades to be involved. Installation coordination includes location of the correct placement of thermowells, flow switches, dampers, control valves, control power circuits, etc. Care must be exercised to identify locations that meet the requirements of the manufacturer including upstream and downstream distances, pressures, temperatures, etc.
5. All signal wiring requiring shielding shall have the shield terminated at the controller end only.
6. Label all wiring with permanent labels indicating the point device identifier. Install a phenolic label mounted at the device indicating the device type and point identifier name.
7. All field devices shall be labeled with 1" x 3" phenolic labels. Labels shall include the point name and device name. Labels for EMS controllers shall indicate the breaker and panel number of the power source. Labels shall be glued, attached with screws, or copper wire in the case of valves and actuators.
8. On each terminal unit and fan control unit provide an adhesive film label showing the unit identification of the device as it appears on the construction drawings. The label shall be approximately three inches high by five inches wide, with the identification characters approximately one inch high. The characters shall be printed in black on an

orange background. The label shall be placed on the unit at a location easily observable by maintenance personnel.

B. All software development shall be completed by EMS programmers that have been factory trained in programming and graphic development techniques of the EMS.

3.2 NETWORKING/COMMUNICATION

A. General

1. All LANs shall strictly be installed in a manner recommended by the manufacturer and Owner's communications personnel based on the environment, communications speed requirements, and distance. All LAN media shall be installed in a manner that provides protection from physical damage and interference from RF or other electrical sources.

B. Campus Local Area Network

1. All media required to connect Operator Workstations or Network Area Controllers to the Campus Local Area Network shall be installed with materials and procedures that comply with the requirements of the Owner's communications personnel and the EMS equipment manufacturer.

C. Local Building Automation Networks

1. The Local Building Automation Networks shall be installed with materials and procedures in strict compliance with the requirements of the EMS equipment manufacturer.

3.3 BACnet COMPATIBILITY AND OBJECT REQUIREMENTS

A. All EMS software shall be developed in accordance with the approved PICS for the device. See Part 1 of this Section.

B. The Out-Of-Service property shall be writable using BACnet services for all Analog, Binary, Multi-state, Loop, and Program objects.

C. All Analog (Input, Output, and Value), Loop, and Multi-state (Input, Output, and Value) objects shall have the capability of using the Change of Value reporting mechanism and the COV-Increment shall be writable using BACnet services.

D. PID loops shall be represented by Loop objects, with writable tuning constant properties.

3.4 NETWORK AREA CONTROLLERS (NAC)

A. 120 VAC Power shall be provided to each NAC as the work of Division 16. If a NAC requires power at 48 VAC/VDC or lower or at a location other than as shown on the Drawings, it shall be the work of this Section to provide and install all necessary conduit, wiring, transformers, etc., and make the final connections. All power shall be verified as work of this Section prior to powering the controllers.

B. It shall be work of this Section to provide connections of all NACs to the existing Campus Local Area Network and to the Local Building Automation Networks.

3.5 EMS CONTROLLERS

A. General

1. New controllers will be installed where required or indicated on the Drawings; however, in no case shall more than 90% of the maximum attached potential node limitations be designed nor shall more than 75% of the controller RAM be utilized by the programming code specified herein, including trendings and global programming. If these limits are met, additional controllers or RAM must be added.
2. All controllers shall be installed in accordance with manufacturer's instructions. Electrical power shall be provided to each device at the appropriate voltage and frequency. If a controller requires power at a different voltage or at a location other than as shown on the Drawings, it shall be the work of this Section to provide and install all necessary conduit, wiring, transformers, etc., and make the final connections. All power shall be verified as work of this Section prior to powering the controllers.
3. All EMS controllers shall be installed in a NEMA rated enclosure appropriate to the environment in which it will be installed that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure. If located outdoors or in mechanical rooms or similar harsh environments all penetrations of the enclosure shall be made through the bottom of the enclosure and not the top or sides.

B. Communications

1. It shall be work of this Section to develop the Local Building Automation Networks. This work includes installation and troubleshooting of new media. All devices shall be connected to Local Building Automation Network in a manner recommended by the manufacturer based on the environment, communications speed requirements, and distance.

C. Input/Output

1. The installation of all EMS field control components and the associated I/O wiring back to the respective controller will be installed under this Section of the Specification. Each point shall be checked by the Contractor for voltage, short circuit, etc., prior to termination to the controller to prevent any damage to the controller.

D. Software Requirements

1. All Sequences of Operation as stated in the Contract Documents are to be implemented.

E. Alarms

1. Alarms shall be provided as stated in the Contract Documents.
2. Alarms shall be suppressed when equipment has been intentionally forced to an inoperative status (e.g., night setbacks).

F. Minimum Runtimes

1. All digital output points shall have a minimum runtime as stated in the Contract Documents Sequence or Operations, otherwise as appropriate to the application, to prevent accidental short cycling.

G. Trend Analysis

1. The system shall be configured to trend those system points stated in the Contract Documents. Date and time stamps shall accompany all trend data. The initial interval for all trend logs shall be configured to be 15 minutes.

3.6 INPUT/OUTPUT AND INTERLOCK WIRING

A. See Part 2 of this Section.

3.7 EQUIPMENT CONNECTIONS

A. EMS Class II field wiring for all non-control device applications shall be installed under this Section of the Specification. This includes equipment such as VFDs, chillers, boilers, etc., which may have point types including status or alarm monitored from an equipment supplier Class C contact or analog control signals to equipment, etc.

END OF SECTION 25 5000

SECTION 26 0500 - COMMON WORK REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 1 Specification Sections apply to all Sections of Division 26.

B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 26 and form a part of the contract.

C. Division 1, Coordination, for additional requirements.

D. Division 1, Cutting and Patching, for additional requirements.

E. Division 1, Submittals, for additional requirements.

F. Division 7, Firestopping, for additional requirements.

G. Division 7, Joint Sealants, for additional requirements.

H. Division 9, Painting, for additional requirements.

I. Division 31, Site Work for Trenching, Backfilling and Compaction requirements.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals
2. Coordination Drawings
3. Record Documents
4. Maintenance Manuals
5. Rough-Ins
6. Electrical Installations
7. Cutting and Patching

1.3 CODES AND PERMITS

A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition, the Uniform International Building Code, Latest Edition as adopted and interpreted by the State of New Mexico, City of Las

Cruces, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Secure and pay for all permits necessary for performance of the work. Pay for all utility connections unless otherwise specified herein.

C. The following lists applicable codes and standards that, as a minimum, shall be followed.

Applicable county and state electrical codes, laws and ordinances.
National Electrical Manufacturer's Association Standards
National Electrical Code
National Electrical Safety Code
Underwriters Laboratories, Inc. Standards
American National Standards Institute
American Society for Testing Materials Standards
Standards and requirements of local utility companies
National Fire Protection Association Standards
Institute of Electrical and Electronics Engineers Standards
Insulated Cable Engineers Association
Occupational Safety and Health Act
Uniform Fire Code
Americans with Disabilities Act
Commercial and Industrial Insulation Standards (MICA)

1.4 RECORD DRAWINGS

A. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Use red color to indicate additions or corrections to prints, green color to indicate deletions, and yellow color to indicate items were installed as shown. Keep record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect, Owner's Representative and Contracting Officer during the construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set. Transmit drawings to the Architect at the conclusion of the project for delivery to the Owner's Representative.

1.5 QUALIFICATIONS

A. All electricians shall be skilled in their respective trade.

1.6 SUBSTITUTIONS

A. Identification of Division 26 equipment, fixtures, and materials listed within this Specification and in the Equipment Schedules on the drawings, which are identified by manufacturer's name, trade name,

and/or model numbers are generally not meant to give preference to any manufacturer, but are provided to establish the design requirements and standards.

B. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical panels, starters, gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls, which shall conform to the manufacturer's recommendations and these specifications. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.

C. Equipment submitted for substitution shall be approved in writing by the Owner or his representative and shall be accompanied by the following:

1. A sample of each item submitted for substitution shall accompany the submittal.
2. Provide a unit price quotation with each item intended for substitution. Include a unit price for the specified item and a unit price for the intended substitute item. Provide a total (per item) of the differential payback to the Owner should the intended substitute item be approved as equivalent to that which is specified.
3. Reimburse the Owner for the Architect/Engineer's additional services required to review and process substitutions.

D. Substitutions shall be approved in writing by the Owner or his representatives. The determination of the Owner shall be final.

1.7 PRIOR APPROVAL

A. Requirements for prior approval in Division 1 or other sections of this specification do not override the requirements of this section.

1.8 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.9 DEFINITIONS

A. Definitions of terms will be found in the National Electrical Code.

B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.

C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane,

Piscataway, New Jersey 08855-1331.

D. "Provide" means furnish, install, connect and test unless otherwise noted.

1.10 SUBMITTALS

A. The Contractor shall submit submittal brochures of equipment, fixtures and materials to be furnished under Division 26.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. Install equipment in accordance with the manufacturer's recommendations. Provide accessories and components for optimum operation as recommended by the manufacturer.

D. Costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification from the Architect/Engineer that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter to the Architect/Engineer.

F. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. **Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 3 feet clear in front of all electrical equipment and panels as defined by the National Electrical Code.** Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

G. Shop Drawings: Unless the following information is included, shop drawings will be returned unchecked:

1. Cover sheet for each submittal, listing equipment, products, and materials, and referencing data and sections in Specifications and drawings. Clearly reference project name and provide space for a review stamp.
2. Cover sheet shall clearly identify deviations from specifications, and justification.
3. Include all related equipment in a single submittal to allow complete review. Similar

equipment may be submitted under a common cover sheet.

4. Size, dimensions, and weight of equipment.
5. Equipment performance under specified conditions, not a copy of scheduled data on drawings.
6. Indicate actual equipment proposed, where data sheets indicate more than one (1) device or equipment.

H. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

I. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted, for review by the Architect, with the shop drawing submittals of the substituted. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

J. Submittals and one (1) resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

K. See Division 1 for additional submission requirements.

1.11 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1, Section 01 78 23 - PROJECT CLOSEOUT. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Manufacturer’s printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
2. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1, Section "PROJECT COORDINATION", to a scale of 1/4" = 1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
b. Exterior wall and foundation penetrations.
c. Fire-rated wall and floor penetrations.
d. Equipment connections and support details.
e. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

1.13 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.14 DRAWINGS AND SPECIFICATIONS

A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.

B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.

C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Architect.

D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.

E. The Architect shall interpret the drawings and the specifications. The Architect's interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished there under shall be accepted as final and conclusive.

F. In the case of conflicts not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.

G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.15 SIMILAR MATERIALS

A. All items of a similar type shall be products of the same manufacturer.

B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.

C. Examples of similar equipment types include but are not limited to:

1. Power Circuit Breakers
2. Enclosed Case Circuit Breakers
3. Batteries
4. UPS
5. TVSS
6. Engine-Generators
7. Motor Starters
8. Transformers
9. Panelboards
10. Disconnects
11. Fuses
12. Transfer Switch
13. Computer Power Distribution Units

1.16 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.17 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of this project site. Contractor will verify altitude of site prior to ordering any equipment. Adjustments to manufacturer's ratings must be made accordingly.

2.3 EQUIPMENT REQUIREMENTS

A. Approved Equipment and Conductors: ALL equipment and conductors shall be listed and labeled by a nationally recognized testing laboratory (NRTL). The NRTL shall be listed by the federal occupational safety and health administration. Conformance with the State of New Mexico Electrical Code article 110.2 is required for ALL equipment and conductors.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

B. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefore, shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval. All changes shall be marked on record drawings.

C. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

D. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).

E. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 26 with the associated architectural, structural, and mechanical work than is normally necessary for a more typical facility.

F. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with all other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Branch circuits in offices and computer areas to have an individual neutral for each phase.
9. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
10. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
11. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
12. Install access panel or doors where units are concealed behind finished surfaces.
13. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

3.3 FIELD MEASUREMENTS

A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall report any work which must be

corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.4 EQUIPMENT SUPPORT

A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 PAINTING

A. All finish painting of electrical systems and equipment will be under "Painting," unless equipment is hereinafter specified to be painted.

B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Architect, Owner's Representative, and Building Manager.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Architect, and Owner's Representative.

C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect and Owner's Representative prior to such storage.

D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect, and Owner's Representative**.**

3.7 EXCAVATION

A. Provide all excavation, trenching and backfilling required.

B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer's printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.11 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.12 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1, Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

    a. Remove and replace defective Work.
    b. Remove and replace Work not conforming to requirements of the Contract Documents.
    c. Remove samples of installed Work as specified for testing.
    d. Install equipment and materials in existing structures.
    e. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. During cutting and patching operations, protect adjacent installations.
6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.13 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Architect, and Owner's Representative who shall make such compromises as he deems necessary and desirable.

3.14 OWNER FURNISHED EQUIPMENT

A. Some equipment has either been pre-purchased or is in the process of being pre-purchased by the Owner. It has been necessary to take this approach in order to meet the construction deadlines of the project. The pre-purchased equipment will be indicated on the drawings.

B. Included in Work Scope:

1. Follow and expedite the delivery of each piece of equipment to assure the equipment delivery stays on schedule. Notify the Owner of any problems or delays.
2. Receive, unload, uncrate, and install each item of pre-purchased and Owner furnished equipment.
3. Confirm that each item has been received complete and as specified. Notify the Owner and the manufacturer's representative in writing of any deficiencies or damage.
4. Coordinate with the manufacturer's representative on start-up and provide factory personnel and provide all necessary personnel to assist Owner's operating personnel and/or

manufacturer's service personnel in start-up and commissioning.

5. Provide all items not listed as pre-purchased.

C. Submittals, installation instructions, and warranty provisions for pre-purchased equipment will be furnished to the Contractor by the Owner.

3.15 CONCRETE BASES AND HOUSEKEEPING PADS

A. Install concrete bases and housekeeping pads under all freestanding electrical equipment unless otherwise noted.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all anchor bolts, etc. Coordinate weight of concrete bases and housekeeping pads with the structural engineer.

C. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with Carborundum block after stripping forms. Tops shall be level. Provide dowel rods or other required material in floor for lateral stability and anchorage.

3.16 TESTS

A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect, and Owner's Representative two weeks in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.17 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish the complete operating and maintenance instructions covering all units of electrical equipment herein specified together with parts lists. Furnish four (4) copies of all the literature; each shall be suitably bound in loose leaf book form.

B. Operating and maintenance manuals as required herein shall be submitted for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the electrical systems and equipment for a period of three (3) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

D. The Contractor shall video tape the instruction and training sessions using a VHS or DVD camcorder, and at the completion and acceptance (by Owner and Architect) of the training sessions, the Contractor shall submit (2) copies of the video tape.

3.18 CERTIFICATIONS

A. Before receiving final payment, certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Architect, and Owner's Representative including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.19 INTERRUPTING SERVICES

A. Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing building electrical telephone, fire alarm, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written review.

3.20 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Architect/Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Architect/Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Architect/Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 26 0500

DIVISION 26 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.
PROJECT:_____

We hereby submit for your consideration the following product instead of the specified item for the above project:
Section: _____ Page:_____ Paragraph/Line:_____ Specified Item:_____
Proposed Substitution: _____
Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions?
   YES ☐ NO ☐
   If YES, explain:_____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
   _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
   _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
   _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
   _____
9. Is substitution identical in appearance and function to specialized product? YES ☐ NO ☐

Submitting Firm: _____ Date: __
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted:_____ Not Accepted:_____ Received Too Late:_____
By:_____ Date:_____
Remarks:_____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2:_____

Date: _____

SECTION 26 0502 - DEMOLITION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 1 Specification Sections apply to this Section.

1.2 SCOPE OF WORK

A. Provide all material, equipment and labor as required to remove, relocate and/or reconnect all electrical work identified in these specifications and indicated on the drawings.

1.3 SUMMARY

A. This Section includes limited scope, general construction materials and methods for application with electrical installations as follows:

1. Selective demolition including:

    a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
    b. Dismantling electrical materials and equipment made obsolete by these installations.

2. Excavation for underground utilities and services, including underground raceways.
3. Miscellaneous metals for support of electrical materials and equipment.
4. Nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
5. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
6. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment.

1.4 PROJECT CONDITIONS

A. Conditions affecting selective demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions affecting excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
3. Existing utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
4. Remove existing underground utilities indicated to be removed.

    a. Uncharted or incorrectly charted utilities: Contact utility owner immediately for instructions.
    b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Owner's Representative prior to utility interruption.

5. Use of explosives is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Verify field measurements and circuiting arrangements as shown on drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.

D. Beginning of demolition means Contractor accepts existing conditions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Disconnect and remove electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate service outages with Owner a minimum of 96 hours prior to outage.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical system: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from the Owner's Representative at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of this section.

B. Remove, relocate and extend existing installations to accommodate new construction. Recircuit and reconnect all electrical lighting, outlets, and equipment not scheduled for removal that have become disconnected due to demolition work.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit serving them is removed. Provide blank cover for abandoned outlets which are not removed. Provide blank cover for abandoned outlets which are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work. Any damage to building, piping or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.

J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

L. Removal and replacement of ceiling tile(s) to perform work operations shall be the responsibility of the Contractor. The Contractor shall be responsible for replacement of any ceiling tiles or framework that may become damaged at no cost to the Owner

M. Housekeeping Pads and Equipment Foundations: Remove for all equipment removal. Backfill as required, compact to 95 percent modified Proctor density, and pour floor slab or resurface floor to match existing.

N. Conduit in Concealed Locations: Remove conductors, cap both ends of conduit, and label conduit as "Abandoned" at both ends. Where conduit runs below grade, cap both ends of conduit and abandon in place. Where conduit runs below floor slab, additionally, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match existing.

O. Motor Control Centers: Where MCCs serve equipment to be removed and no new equipment is to be served, leave starter in place, remove existing labels, and install new label "Spare Size x Starter."

3.3 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaries: Remove existing luminaries for cleaning, as indicated on drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

D. Materials and equipment to be salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

E. Disposal and cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

3.4 INSTALLATION

A. Install relocated materials and equipment under the provisions of this section.

3.5 ITEMS SALVAGED TO OWNER

A. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner. Move and store in dry location as directed.

END OF SECTION 26 0502

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 26 0529 "Hangers and Supports for Electrical Systems" for supports and anchors for fastening cable directly to building finishes..
2. Section 26 0553 "Identification for Electrical Systems" for insulation color coding and wire cable markers.

1.3 DEFINITIONS

A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type XHHW-2.

D. Multi-conductor Cable: Metal Clad type “MC” cable not allowed.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; except VFC cable which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Not acceptable. All conductors in a raceway path.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type XHHW-2, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspaces: Type XHHW-2, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW-2 single conductors in raceway.

F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 0533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 0553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 8413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A Brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad sectional type; 5/8 by 96 inches (16 by 2400 mm).

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturers recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.
5. Connection at service entrance: Welded connectors
6. Connection at main grounding buss: Welded Connectors

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Metal-clad cable runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Building is existing and Bonding will require new straps or the utilization of existing if adequately sized.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment. Both new and existing equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural

drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Section 26 0548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated **s**teel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 5000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 3053 "Miscellaneous Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and Section 09 91 23 "Interior Painting for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 0529

SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 27 0528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Section 28 0528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney.

6. Picoma Industries.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. FMC: Comply with UL 1; zinc-coated steel.

I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements**,** provide products by one of the following, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corporation.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions; Carlon Electrical Products.
10. Niedax-Kleinhuis USA, Inc.
11. RACO; Hubbell.
12. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

I. RTRC: Comply with UL 1684A and NEMA TC 14.

J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Fittings for LFNC: Comply with UL 514B.

L. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

M. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman.

3. Mono-Systems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:

1. Allied Moulded Products, Inc.
2. Hoffman.
3. Lamson & Sessions; Carlon Electrical Products.
4. Niedax-Kleinhuis USA, Inc.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

1. Manufacturers: Subject to compliance with requirements provide products by one of the following, but are not limited to, the following:

    a. Mono-Systems, Inc.
    b. Panduit Corp.
    c. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:

    a. Hubbell Incorporated.
    b. Mono-Systems, Inc.
    c. Panduit Corp.
    d. Wiremold / Legrand.

D. Tele-Power Poles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:

    a. Mono-Systems, Inc.
    b. Panduit Corp.
    c. Wiremold / Legrand.

2. Material: Galvanized steel with ivory baked-enamel finish.
3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:

1. Wiremold / Legrand
2. Adalet.

3. Cooper Technologies Company; Cooper Crouse-Hinds.
4. EGS/Appleton Electric.
5. Erickson Electrical Equipment Company.
6. FSR Inc.
7. Hoffman.
8. Hubbell Incorporated.
9. Kraloy.
10. Milbank Manufacturing Co.
11. Mono-Systems, Inc.
12. O-Z/Gedney.
13. RACO; Hubbell.
14. Robroy Industries.
15. Spring City Electrical Manufacturing Company.
16. Stahlin Non-Metallic Enclosures.
17. Thomas & Betts Corporation.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep.

N. Gangable boxes are allowed up to a four devices.

O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

P. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in door front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC, IMC, and EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealants recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway

section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3. Exterior surface raceways to be painted to match exterior boxes, gear, enclosures, etc. Typically this will be color DESERT TAN. Verify with architect and owner prior to painting.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. Support boxes from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 0533

SECTION 26 0536 – CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cable trays and accessories.

B. Related Sections include the following:

1. Division 7, Section Firestopping for firestopping materials and installation requirements.
2. Division 26, Section 26 0529, Hangers and Supports for Electrical Systems for cable tray supports not specified in this Section.

1.3 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray.

B. Shop Drawings: Detail fabrication and installation of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Design Calculations: Verify loading capacities for supports.

D. Coordination Drawings: Include floor plans and sections drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural and mechanical elements.

E. Factory-certified test reports of specified products, complying with NEMA VE 1.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements specified in "Field Quality Control" Article.

G. Maintenance Data: For cable trays to include in the maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Listing and Labeling: Provide cable trays and accessories specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

C. Comply with NEMA VE 1, Metal Cable Tray Systems, for materials, sizes, and configurations.

D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

B. Notify Architect not less than 2 days in advance of proposed utility interruptions.

C. Do not proceed with utility interruptions without Architect's written permission.

1.6 COORDINATION

A. Coordinate layout and installation of cable tray with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-Line Systems, Inc.
2. Chalfant Cable Trays.
3. GS Metals Corp.
4. Husky: MP Husky Corp.
5. Mono-Systems, Inc.
6. P-W Industries, Inc.

2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Steel, hot-dip galvanized after fabrication, complying with ASTM A 123, Class B2.

B. Cable Trays, Fittings, and Accessories: Aluminum, complying with Aluminum Association's alloy 6063-T6 for rails, rungs, and cable trays, and alloy 5052-H32 or 6061-T6 for fabricated parts.

C. Protect steel hardware against corrosion by galvanizing according to ASTM B 633 or cadmium

plating according to ASTM B 766.

D. Fabricate cable tray products with rounded edges and smooth surfaces.

E. Sizes and Configurations: Refer to Cable Tray Requirments on Drawings for specific requirements for types, materials, sizes, and configurations.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26, Section 26 0553, Identification for Electrical Systems.

C. Materials and fastening are specified in Division 26, Section 26 0501, Common Work Results for Electrical.

2.5 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of cable trays. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports securely to building structure as specified in Division 26 unless otherwise indicated.

1. Locate and install supports according to NEMA VE 1.
2. Design supports, including fastenings to the structure, to carry the greater of the calculated load multiplied by a safety factor of 4 or the calculated load plus 200 lb.

D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independently of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Install expansion connectors where cable tray crosses a building expansion joint and in cable tray runs that exceed 90 feet. Space connectors and set gaps according to NEMA VE 1.

F. Make changes in direction and elevation using standard fittings.

G. Make cable tray connections using standard fittings.

H. Locate cable tray above lay-in ceiling (except in lab areas), unless accessibility to cable tray is required or unless otherwise indicated. Refer to drawings for cable tray requirements.

I. Seal penetrations through fire and smoke barriers according to Division 7 Section Firestopping.

J. Sleeves for Future Cables: Install capped sleeves for future cables through firestopping-sealed cable tray penetrations of fire and smoke barriers.

K. Workspace: Install cable trays with sufficient space to permit access for installing cables.

3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's instructions.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 WARNING SIGNS

A. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.5 FIELD QUALITY CONTROL

A. Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections.

B. Anchorage: Test pullout resistance for toggle bolts and powder-driven threaded studs for each type and size of anchorage material.

1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales, required for reliable testing.
2. Obtain Architect's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener.

C. Replace malfunctioning units.

3.6 CLEANING

A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches and abrasions.

3.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure cable tray is without damage or deterioration at the time of Substantial completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

B. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 0536

SECTION 26 0543 – UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Ducts in direct buried duct banks.
2. Ducts in concrete encased duct banks.
3. Handholes and handhole accessories.

B. Related Sections include the following:

1. Division 26, Section 26 0526, Grounding and Bonding for Electrical Systems for grounding electrodes, counterpoise conductors, clamps and connectors for grounding metallic manhole and handhole accessories, and testing of grounds.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Manhole and handhole hardware.
2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
3. Duct bank materials, including spacers and miscellaneous components.
4. Warning tape.

B. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:

1. For manholes:

a. Duct sizes and locations of duct entries.
b. Reinforcement details.
c. Manhole cover design.
d. Step details.
e. Grounding details.
f. Dimensioned locations of cable rack inserts, pulling-in irons, and sumps.

2. For precast manholes and handholes, shop drawings shall be signed and sealed by a qualified professional engineer and shall show the following:

a. Construction of individual segments.
b. Joint details.
c. Design calculations.

C. Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.

D. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.

E. Product Test Reports: Indicate compliance of manholes with ASTM C 857 and ASTM C 858, based on factory inspection.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFP A 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver ducts to project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect as least two (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect’s written permission.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Underground Precast Concrete Utility Structures:

    a. Brooks Products, Inc.
    b. Carder Concrete Products
    c. Christy Concrete Products, Inc.
    d. Elmhurst-Chicago Stone Company
    e. Riverton Concrete Products
    f. Rotondo Precast/Old Castle
    g. Utility Vault Company
    h. Wausau Concrete Company

2. Frames and Covers:

    a. Campbell Foundry Company
    b. East Jordan Iron Works, Inc.
    c. Mckinley Iron Works, Inc.
    d. Neenah Foundry Company

3. Nonmetallic Ducts and Accessories:

    a. Arnco Corporation
    b. Beck Manufacturing Inc.
    c. Cantex, Inc.
    d. Certainteed Corporation, Pipe & Plastics Group
    e. ElecSys, Inc.
    f. Electri-Flex Company
    g. Ipex, Inc.
    h. Lamson & Sessions; Carlon Electrical Products
    i. Manhattan/CDT/Cole-Flex
    j. Spiraduct/AFC Cable Systems, Inc.

2.2 CONDUIT

A. Conduit and fittings are specified in Division 26, Section 26 0533, Raceways and Boxes for

Electrical Systems.

2.3 DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and 514B.

2.4 HANDHOLES

A. Cast Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading.

B. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of handhole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.

C. Fiberglass Handholes: Molded fiberglass, with 6-inch square cable entrance at each side and weatherproof cover with nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.

D. Cover Legend: 'ELECTRIC.'

PART 3 - EXECUTION

3.1 APPLICATION

A. Underground Ducts for Electrical Cables Higher than 600V: Type EPC-40-PVC, concrete-encased duct bank.

B. Underground Ducts for Electrical Branch Circuits: Type DB-60-PVC, direct buried duct bank.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 2 Section, Earthwork, but do not use heavy duty hydraulic operated, compaction equipment. The entire depth of trench shall be backfilled in 12 inch layers, and each layer shall be moistened and compacted to 95% below any walks, paving or structures and to 90% in open areas. Compaction shall be based on Standard Proctor Tests conducted on the materials used.

B. Restore surface features at areas disturbed by excavation and re-establish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore

vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Section 'Landscaping.'

D. Restore disturbed pavement. Refer to Division 1 Section, Cutting and Patching.

3.3 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slop of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions.

B. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet, both horizontally and vertically, at other locations.

C. Use solvent cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches o.c. for 5 inch ducts and vary proportionately for other duct sizes. Change from regular spacing to end bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

E. Building Entrances: Make a transition from underground duct to conduit at least ten feet outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below.

1. Concrete Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Direct Buried, Nonencased Ducts at Nonwaterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Calk space between conduit and sleeve with duct sealing compound on both sides for moisture tight seal.
3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

F. Concrete Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall

directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench

bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4 inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use walls of trench to form side walls of duct bank where soil is self supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Minimum Clearances Between Ducts: Three (3) inches between ducts and exterior envelope wall, two (2) inches between ducts for like services, and four (4) inches between power and signal ducts.
6. Depth: Install top of duct bank at least 24 inches below finished grade in nontraffic areas and at least 30 inches below finished grade in vehicular traffic areas, unless otherwise indicated.

G. Direct Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts.
2. Install expansion fittings as shown on shop drawings.
3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 2, Section, Earthwork for pipes less than 6 inches in nominal diameter.
4. Backfill: Install backfill as specified in Division 2, Section, Earthwork. After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand temper only. After placing controlled backfill over final tier, complete backfilling normally.
5. Minimum Clearances Between Ducts: Three (3) inches between ducts for like services and six (6) inches between power and signal ducts.
6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

H. Warning Tape: Bury warning tape approximately 12 inches above all concrete encased duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.

I. Stub Ups: Use rigid steel conduit for stub ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.

J. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 PSIG hydrostatic pressure.

K. Pulling Cord: Install 100 lbf test nylon cord in ducts, including spares.

3.4 MANHOLE AND HANDHOLE INSTALLATION

A. Elevation: Install hand holes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface one (1) inch above grade.

3.5 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

B. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80% fill of the duct. If obstructions are indicated, remove obstructions and retest.

C. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.6 CLEANING

A. Pull leather washer type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 0543

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.

G. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

H. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

F. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

G. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

H. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

F. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

G. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.

2.4 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils (0.1 mm).
3. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
3. Arc Flash Warnings: Refer to specification section 260574 for Label requirements.

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 25-foot (15-m) maximum intervals in straight runs, and at 10-foot (7.6-m) maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits 15A or More and 120V to ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 10-foot (3-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend, system voltage, and panel circuit number(s). System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, use self-adhesive, self-laminating polyester labels conductor or cable designation, origin, and destination.

F. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive, self-laminating polyester labels with the conductor designation.

G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

N. Wiring Device Identification: For each receptacle, non-low voltage switch, or similar wiring device provide identification label.

1. Labeling Instructions: Label each device describing the panel and circuit number feeding it. Use clear white label with 3/16” high black font.

O. Identify Raceways and Exposed Cables with Color Banding: Band exposed and accessible raceways of the systems listed below for identification.

1. Bands: Pre-tensioned, snap-around, colored plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 3/4 inches wide standard color tape, completely encircling conduit, and place adjacent bands of 2-color markings in contact, side by side.
2. Locate bands at changes in direction, at penetrations of walls and floors, at 20-foot maximum intervals in straight runs, and at 10 feet in congested areas.
3. Colors: As follows:

    a. 120/208 Volt – Black.
    b. 277/480 Volt – Blue.
    c. Emergency 120/208 Volt – Black and orange.
    d. Emergency 277/480 Volt – Blue and orange.
    e. Fire-Alarm System: Red.
    f. Fire-Suppression Supervisory and Control System: Red and yellow.
    g. Combined Fire-Alarm and Security System: Red and blue.
    h. Security System: Blue and yellow.
    i. Mechanical and Electrical Supervisory System: Green and blue.
    j. Data System: Green and yellow.
    k. Television Systems: Green and White.
    l. Sound/PA: Orange.
    m. Telephone: Orange and yellow.

P. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label 4 inches (100 mm) high.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled: Panel 1H1 120/208V, 3-PH, 4-wire fed from panel MDR-CCT#4.

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.

d. Switchgear.
e. Switchboards.
f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
g. Emergency system boxes and enclosures.
h. Motor-control centers.
i. Enclosed switches.
j. Enclosed circuit breakers.
k. Enclosed controllers.
l. Variable-speed controllers.
m. Push-button stations.
n. Power transfer equipment.
o. Contactors.
p. Remote-controlled switches, dimmer modules, and control devices.
q. Battery-inverter units.
r. Battery racks.
s. Power-generating units.
t. Monitoring and control equipment.
u. UPS equipment.

END OF SECTION 26 0553

SECTION 26 0573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals [**shall**] [**may**] be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provided by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.
2. Medium-voltage controller.
3. Motor-control center.
4. Distribution panelboard.
5. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241, IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 26 0573

SECTION 26 0574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary

submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Specialist.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by one of, but are not limited to, the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

G. Arc-Flash Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.

d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 72 "Overcurrent Protective Device Short-Circuit Study."
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Control panel.

3.5 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 26 0574

SECTION 26 0800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. Section 01 9113 – General Commissioning Requirements

B. Section 22 0800 – Commissioning of Plumbing Systems

C. Section 23 0800 – Commissioning of HVAC Systems

1.3 REFERENCES (Not Used)

1.4 SUBMITTALS (Not Used)

PART 2 - PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EQUIPMENT AND STARTUP TESTING PREPARATION

A. Installing Contractors shall work with the CM/GC to schedule Construction Checklists and Functional Performance Testing. The CM/GC shall integrate this information into the project schedule, and keep Owner, CxA and Installing Contractors informed of any conflicts or schedule changes.

B. Installing Contractor shall perform equipment startup and complete Construction Checklists. Only individuals having direct knowledge that a line item task was actually performed will respond to that item in the electronic Pre-Functional Checklist system. ***Failure to complete Construction Checklists by installing contractors may result in pay applications being delayed or withheld until all commissioning documentation is up to date and commensurate with the project progress.***

C. Installing Contractor shall document and record all equipment deficiencies and discrepancies encountered using computers, I pads, tablets, or smartphones. All issues generated by CxA shall be responded to using the commissioning website tool and corrected by Installing Contractor before scheduling Functional Performance Testing.

D. Installing Contractor shall give at least one-week notice to CxA before start-up of each item of equipment. Installing Contractors shall accommodate CxA's time restrictions by making modifications to the commissioning schedule when so requested by CxA. Verification by CxA of proper equipment startup is required prior to Functional Performance Testing.

E. Set lighting control occupancy sensors to proper sensitivity, time duration, and field of view per contract documents.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. A sample Construction Checklist is included in 3.04. The sample is provided to give the Installing Contractor a general idea of the work required to complete Construction Checklists. Additional Construction Checklists will be added, modified or deleted in the Commissioning Plan as it's developed by the Commissioning Team.

3.2 GENERAL TESTING REQUIREMENTS

A. Installing Contractors shall provide technicians, instrumentation, and tools to perform commissioning Functional Tests at the direction of the CxA.

B. CxA shall witness and document results of Functional Test procedures. Installing Contractor shall conduct tests under direction of CxA. CxA shall have authority to determine success of all tests.

C. Installing Contractor shall give at least one-week notice to CxA before performing Functional Tests of equipment and systems. Installing Contractors shall accommodate CxA's time restrictions by making modifications to the commissioning schedule when so requested by CxA.

D. Functional Testing shall be conducted after Construction Checklists, testing, and startup, has been satisfactorily completed.

E. CxA shall develop specific test procedures and Functional Test forms to verify and document proper operation of each piece of equipment or system. Prior to test execution, CxA will provide a copy of test procedures to Installing Contractor. Installing contractor will review tests for feasibility, safety and equipment warranty protection. CxA will post commissioning functional test procedures to commissioning website for review by Owner, CM/GC, A/E and other Commissioning Team members.

F. Any instances of deficiency or nonconformance issues will be noted and reported to CM/GC and Owner on standard non-compliance Functional Test Forms. CxA will maintain an issues log, and Installing Contractor shall be responsible for performing work necessary to remove items from the log.

G. Every effort shall be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. CxA shall not overlook deficient work or slacken acceptance criteria to satisfy scheduling or cost issues unless directed to do so by Owner.

H. The Installing Contractor is responsible for all equipment and systems deficiencies and troubleshooting throughout all stages of construction and acceptance. Responsibility for

correcting and retesting lies solely with Installing Contractors. The CxA may recommend solutions to problems, but is not required to do so. The Installing Contractor shall not rely on such recommendation unless directed in writing to do so by Owner, and shall, in no event, make any claim against the CxA for any such recommendation.

I. Functional Test procedures shall include all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors. The CxA may direct that set points be altered when simulating conditions is not practical, and may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical

J. Tests will be performed using design conditions whenever possible. Installing Contractors shall be responsible for conducting off-season tests. All CxT members will coordinate off-season testing requirements.

K. Any test not completed due to building structure, required occupancy condition, or other cause, may be delayed upon approval of Owner. Such tests shall be rescheduled as soon as possible

3.4 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. The requirements of this section shall be applicable to all the Division 26 sections listed in the Commissioning Plan (see section 019113). The Contractor shall contact the CxA in writing to request answers to any questions the Contractor may have or conflicts that are identified. The Commissioning Plan will address those sections that will be Cx as subsystems, as well as those sections that will be Cx together as part of a system or subsystem.

B. Some of the sections listed in the Commissioning Plan are meant to be installed in a specific sequence, such that the construction work under one section must be partially or fully completed before the construction work of another section can begin. While the CxA will address some of these interrelationships in the Commissioning Plan, it is the Contractor's sole responsibility to ensure the proper coordination in construction work between Division 26 sections to insure a smooth Cx process.

C. Division 26 sections to be commissioned. The equipment, components, assemblies and systems to be commissioned as part of this section include, but are not limited to the ones listed below. In case of conflict between this list and the Architect's construction documents and specifications, the construction documents and specifications will take precedence.

1. Electrical Metering such as KW and/or KWH Meters
2. Interior Lighting Controls and associated Devices
3. Exterior Lighting Controls and associated Devices
4. Timeclocks, Astronomical Clocks and light level sensors
5. Modular Dimming Controls
6. Variable Frequency Drives
7. Electrical Generators (if applicable)
8. Automatic Transfer Switches (if applicable)

3.5 SAMPLE CONSTRUCTION CHECKLIST

Lighting Controls

Sections 2

Submittal Data	
1	Submittals have been provided and approved for this equipment
Electrical Checklist	
1	Devices installed per project plans and specifications
2	Devices installed per manufacturer's instructions and specifications
3	All lighting circuits and devices correctly wired and labeled
4	Automatic lighting control functions such as motion sensors, time clocks, and outdoor electronic eyes operate as specified
5	Proper lamp types have been installed per project plans, specs, and submittals
6	Installation of automatic lighting controls is complete and ready for testing

END OF SECTION 26 0800

SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 SWITCHES, OCCUPANCY / DAYLIGHT SENSORS.

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Wattstopper DLM system or owner approved equal.

2.2 RELAY PANELS

1. Wattstopper DLM system or owner approved equal.
2. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

2.3 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 0553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Provide at least 1-day of training.

END OF SECTION 26 0923

SECTION 26 2200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Qualification Data: For testing agency.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ACME Electric Corporation; Power Distribution Products Division.
2. Controlled Power Company.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. Hammond Co.; Matra Electric, Inc.
5. Magnetek Power Electronics Group.
6. Micron Industries Corp.
7. Myers Power Products, Inc.
8. Siemens Energy & Automation, Inc.
9. Sola/Hevi-Duty.
10. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.If all transformers have same enclosure, retain one of two paragraphs and associated subparagraphs below. Retain first paragraph for indoor transformers; second, for outdoor transformers. If several types of enclosures are required for Project, delete paragraphs and indicate enclosure type on Drawings.

D. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

1. Interior Transformer Finish Color: Gray
2. Exterior Transformer Finish Color: Desert Tan

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

    a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
    b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
    c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Fungus Proofing: Permanent fungicidal treatment for coil and core.

N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

O. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 30 to 50 kVA:
2. 51 to 150 kVA:
3. 151 to 300 kVA:
4. 301 to 500 kVA:
5. 501 to 750 kVA:

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

C. Sound Isolation: Final conduit connection to transformer to be made with flexible conduit. Isolation pads to be installed on floor mounted transformers, spring hangers for transformers supported by structure.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 2200

SECTION 26 2416 – PANELBOARDS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
b. Altitude: Not exceeding project site elevation. Contractor to verify site elevation prior to ordering equipment.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager, and Building Manager/Owner no fewer than two weeks in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without written permission.
3. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2- PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush and/or surface mounted cabinets as indicated on plans.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

1) Exterior panelboards to be factory painted DESERT TAN.

b. Back Boxes: Galvanized steel.
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and/or bottom depending on installation requirements.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual vertical sections.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker and/or Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: **Plug-in** circuit breakers.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 0913 "Electrical Power Monitoring and Control."
    f. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3- EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in [**Section 03 3000 "Cast-in-Place Concrete."**] [**Section 03 3053 "Miscellaneous Cast-in-Place Concrete."**]

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:

      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 2416

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge-suppression units.
4. Isolated-ground receptacles.
5. Hospital-grade receptacles.
6. Tamper-resistant receptacles.
7. Weather-resistant receptacles.
8. Snap switches and wall-box dimmers.
9. Solid-state fan speed controls.
10. Wall-switch and exterior occupancy sensors.
11. Communications outlets.
12. Pendant cord-connector devices.
13. Cord and plug sets.
14. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Service-Outlet Assemblies: One for every 10, but no less than one.
2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
3. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of, but are not limited to the following:

a. Cooper; 5351 (single), CR5362 (duplex).
b. Hubbell; HBL5351 (single), HBL5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5361 (single), 5362 (duplex).

2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

a. Cooper; IG5362RN.
b. Hubbell; IG5362.
c. Leviton; 5362-IG.
d. Pass & Seymour; IG5362.

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. General Description:

1. Straight blade, feed through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

D. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following]:

a. Cooper; VGF20.
b. Hubbell; GFR5352L.
c. Pass & Seymour; 2095.
d. Leviton; 7590.

2.4 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:

1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

a. Cooper; 5362BLS.
b. Hubbell; HBL5362SA.
c. Leviton; 5380.
d. Pass & Seymour; 5362BLSP.

2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

C. Isolated-Ground, Duplex Convenience Receptacles:

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

a. Cooper; IG5362BLS.
b. Hubbell; IG5362SA.
c. Leviton; 5380-IG.
d. Pass & Seymour; IG5362BLSP.

2. Description:

a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

a. Single Pole:

1) Cooper; AH1221.
2) Hubbell; HBL1221.
3) Leviton; 1221-2.
4) Pass & Seymour; CSB20AC1.

b. Two Pole:

1) Cooper; AH1222.
2) Hubbell; HBL1222.
3) Leviton; 1222-2.
4) Pass & Seymour; CSB20AC2.

c. Three Way:

1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.
4) Pass & Seymour; CSB20AC3.

d. Four Way:

1) Cooper; AH1224.
2) Hubbell; HBL1224.
3) Leviton; 1224-2.
4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

a. Cooper; AH1221PL for 120 and 277 V.
b. Hubbell; HBL1201PL for 120 and 277 V.
c. Leviton; 1221-LH1.
d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

    a. Cooper; AH1221L.
    b. Hubbell; HBL1221L.
    c. Leviton; 1221-2L.
    d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

    a. Cooper; 1995.
    b. Hubbell; HBL1557.
    c. Leviton; 1257.
    d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

    a. Cooper; 1995L.
    b. Hubbell; HBL1557L.
    c. Leviton; 1257L.
    d. Pass & Seymour; 1251L.

2.6 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.Retain "Products" Subparagraph and list of manufacturers and products below to require specific products or a comparable product from other manufacturers.

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

    a. Cooper; 6252.
    b. Hubbell; DR15.
    c. Leviton; 16252.
    d. Pass & Seymour; 26252.

B. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

    a. Cooper; TR6252.
    b. Hubbell; DR15TR.
    c. Pass & Seymour; TR26252.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

C. Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of, but are not limited to, the following:

    a. Cooper; TWRBR15.
    b. Hubbell; DR15TR.
    c. LevitonTRW15.
    d. Pass & Seymour; TRW26252.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.

D. GFCI, Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

    a. Cooper; VGF15.
    b. Hubbell; GF15LA.
    c. Leviton; 8599.
    d. Pass & Seymour; 1594.

E. GFCI, Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

    a. Cooper; TWRVGF15.
    b. Hubbell; GFTR15.
    c. Pass & Seymour; 1594TRWR.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

F. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

a. Cooper; 7621 (single pole), 7623 (three way).
b. Hubbell; DS115 (single pole), DS315 (three way).
c. Leviton; 5621-2 (single pole), 5623-2 (three way).
d. Pass & Seymour; 2621 (single pole), 2623 (three way).

G. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.

1. Products: Subject to compliance with requirements, provide one, but are not limited to, the following:

a. Cooper; 7631 (single pole), 7633 (three way).
b. Hubbell; DS120IL (single pole), DS320 (three way).
c. Leviton; 5631-2 (single pole), 5633-2 (three way).
d. Pass & Seymour; 2625 (single pole), 2626 (three way).

2. Description: With neon-lighted handle, illuminated when switch is "off."

2.7 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.8 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, thermoplastic with lockable cover.

2.9 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.10 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand.
3. Square D/Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold/Legrand.

B. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks complying with requirements in Section 271500 "Communications Horizontal Cabling."
4. Size: Selected to fit nominal 4-inch (100-mm) cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 4-inch (100-mm) cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 271500 "Communications Horizontal Cabling."

2.11 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold/Legrand.

B. Description:

1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Non-Metal, with manufacturer's standard finish.

2.12 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Back to back devices in common walls are not permitted. Outlet boxes shall be separated by at least one stud wherever possible. In case of outlet boxes in adjacent rooms in the same stud cavity at the same height, provide a layer of expandable spray foam insulation around each box in that cavity. There must be a minimum of a 1" horizontal separation space between boxes of adjacent rooms. If this condition occurs in a fire rated wall, provide a 1 hour fire ratted putty pad to cover the back of the outlets on one side of the partition. Other junction box installation son fire rated walls shall comply with UL requirements.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 0553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 26 2726

SECTION 26 2813 – FUSES

PART 1 -GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, enclosed controllers, and motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches and fuseholders.
3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
4. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.7 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 -PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 10 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Other Branch Circuits: Class J, fast acting.
2. Control Circuits: Class CC, fast acting.

B. Plug Fuses:

1. Motor Branch Circuits: Edison-base type, single element time delay.
2. Other Branch Circuits: Edison-base type, dual-element time delay

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 2813

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.

2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding this project site elevation. Contractor will verify project site altitude prior to ordering any equipment.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager, Building manager/Owner no fewer than two weeks in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without written permission.
4. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate specified or indicated fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Single Throw, 240 and or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Compression type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Compression type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight green ON pilot light.
3. Isolated neutral lug; 200 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac or 24-V dc coil voltage as required by fire alarm system.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following :

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Alarm Switch: One NO and one NC contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.

2.5 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Alarm Switch: One NO and one NC contact that operates only when switch has tripped.
7. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
8. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
9. Electrical Operator: Provide remote control for on, off, and reset operations.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R. Exterior paint color to be “Desert Tan” per NMSU standards.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 3R.

4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 0573 "Overcurrent Protective Device Coordination Study."

END OF SECTION 26 2816

SECTION 26 4313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 26 2413 "Switchboards" for factory-installed SPDs.
2. Section 26 2416 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of, but are not limited to, the following:

1. ABB France.
2. Advanced Protection Technologies Inc. (APT).
3. Eaton Corporation.
4. Emerson Electric Co.
5. GE Zenith Controls.
6. LEA International; Protection Technology Group.
7. Leviton Manufacturing Co., Inc.

8. PowerLogics, Inc.
9. Schneider Electric Industries SAS.
10. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 1.

C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1

1. SPDs with the following features and accessories:

a. Integral disconnect switch.
b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
c. Indicator light display for protection status.
d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
e. Surge counter.

D. Comply with UL 1283.

E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 1200 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277 V or 1000 V for 208Y/120 V.

G. SCCR: Equal or exceed 200 kA.

H. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one, but are not limited to, the following:

1. ABB France.
2. Advanced Protection Technologies Inc. (APT).
3. Eaton Corporation.
4. Emerson Electric Co.
5. GE Zenith Controls.
6. LEA International; Protection Technology Group.
7. Leviton Manufacturing Co., Inc.

8. PowerLogics, Inc.
9. Schneider Electric Industries SAS.
10. Siemens Industry, Inc.
11. SPDs: Comply with UL 1449, Type 1.
12. Include LED indicator lights for power and protection status.
13. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
14. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 160 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

C. Comply with UL 1283.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V

E. SCCR: Equal or exceed 200 kA.

F. Inominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 4313

SECTION 26 5100 – INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-state luminaires that use LED technology.
2. Lighting fixture supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Guides Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79, IES LM-80 and IESNA TM-21-11.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

7. Include lighting calculations for each space using standard reflectances and working plane height of 30" AFF if substitution is being proposed.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of luminaire.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion. Provide separate cost option for 10 year warranty to owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: All luminaires indicated on plans are specific to the project. No substitutions are allowed without written owner approval. Any alternates/substitutions provided by the contractor shall be reviewed at the contractor’s expense by the electrical engineer at a rate of $200 per hour.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified[and the luminaire will be fully operational during and after the seismic event

2.3 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. CRI and CCT as shown in drawings.

F. Rated lamp life of 50,000 hours.

G. Lamps dimmable from 100 percent to 0 percent of maximum light output.

H. Exit Signs: Conform to UL 924 and the following:

1. Sign Colors: Conform to local code.
2. Minimum Height of Letters: Conform to local code.
3. Arrows: Include as indicated.
4. Lamps for AC Operation: Light-emitting diodes (LED), 70,000 hours minimum rated life.
5. Extra Materials: Provide 1 Exit Sign for every 50 of each type installed. Furnish at least one of each type.

I. Emergency Lighting Units (bug-eyes): Conform to UL 924. Provide self-contained units with the following features:

1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
2. Charger: Minimum 2-rate, fully automatic, solid-state type, with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. Relay disconnects lamps and battery and automatically recharges and floats on trickle charger when normal voltage is restored.
4. Extra Materials: Provide 1 bug-eye for every 50 of each type installed. Furnish at least one of each type.

2.4 DRIVER (POWER SUPPLY)

A. Physical Characteristics

1. Driver shall be available in an all metal-can construction for optimal thermal performance.
2. Driver shall have a slim profile.
3. Driver shall be provided with integral color-coded connectors.

B. Performance Requirements

1. Driver shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage) with no damage to the Driver.
2. Driver output shall be regulated to +/- 5% across published load range.
3. Driver shall have an easy way to lower the output current, without using the dimming leads.
4. Driver shall have a Power Factor greater than 0.90 for primary application to 50% of full load rating.
5. Driver input current shall have Total Harmonic Distortion (THD) of less than 20% to 50% of full load rating.
6. Driver shall have a Class A sound rating.
7. Driver shall have a minimum operating temperature of -20C (-4F).
8. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.
9. Driver output ripple current shall be less than 15% measured peak-to-average, with ripple frequency >100Hz.
10. Driver performance requirements shall be met when operated to 50% of full load rating.
11. Driver shall be rated for UL Damp and Dry locations.
12. Driver shall have integral common mode and differential mode surge protection of 2.5kV(100kHz 30ohm ring wave).
13. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.
14. Driver shall comply with NEMA 410 for in-rush current limits.
15. Driver shall incorporate an integral means of limiting surges to the LEDs.

C. Regulatory

1. Driver shall not contain any Polychlorinated Biphenyl (PCB).
2. Driver shall be Underwriters Laboratories (UL) recognized Class 2 per UL1310 or Canadian Standards Association (CSA) recognized Class 2 per CSA-C22.2.
3. Driver shall comply with applicable requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, for Non-Consumer equipment.

D. Driver shall be RoHS compliant.

E. Other

1. Driver shall be manufactured in a factory certified to ISO 9001 Quality System Standards.
2. Driver shall carry a five-year limited warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 75C
3. Dimmable drivers shall be controlled by a Class 2 low voltage 0-10VDC controller with dimming range controlled between 1 and 8VDC with source current 150µA.
4. Manufacturer shall have a 10-year history of producing electronic drivers for the North American market.

F. Nominal Operating Voltage: 120 V ac or 277 V ac as indicated in luminaire schedule.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Extra Materials for Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
2. "USE ONLY" and include specific lamp type.
3. Lamp diameter, shape, size, wattage, and coating.
4. CCT and CRI for all luminaires.

2.6 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.7 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

B. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel,

C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

D. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

E. Wall-Mounted Luminaire Support:

1. Wall anchor as recommended by luminaire manufacturer.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Give advance notice of dates and times for field tests.

D. Provide instruments to make and record test results.

E. Prepare test and inspection reports.

3.5 CONNECTIONS

A. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 ADJUSTING AND CLEANING

A. Clean fixtures after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 26 5100

SECTION 26 5612 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes exterior lighting fixtures, lamps, ballasts, pole standards, and accessories.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26, Section 26 5113, Interior Lighting Fixtures, Lamps and Ballasts for interior fixtures, lamps, ballasts, emergency lighting units, and accessories; also for exterior fixtures normally mounted on buildings.
2. Division 26, Section 26 0913, Lighting Control Equipment for programmable lighting control systems, time switches, photoelectric relays, power relays, and contactors.

1.3 DEFINITIONS

A. Fixture: A complete lighting device. Fixtures include a lamp or lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply, including a pole or bracket plus mounting and support accessories.

B. Luminaire: A fixture.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data describing fixtures, lamps, ballasts, and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Outline drawings indicating dimensions and principal features of fixtures.
2. Electrical Ratings and Photometric Data: Certified results of laboratory tests for fixtures and lamps.

C. Wind Resistance Calculations: Certified by a registered professional engineer.

D. Shop Drawings detailing nonstandard fixtures and indicating dimensions, weights, method of field assembly, components, and accessories.

E. Wiring diagrams detailing wiring for control system showing both factory-installed and field-installed wiring for specific system of this Project, and differentiating between factory-installed and field-installed wiring.

F. Field test reports indicating and interpreting test results specified in Part 3 of this Section.

G. Maintenance data for products to include in the operation and maintenance manual specified in Division 1.

1.5 PRIOR APPROVAL

A. General: Submit each item in this article according to the conditions per prior approval outlined in Division 26, Section 26 05 00, Common Work Results for Electrical.

B. Provide a sample of the actual fixture proposed for approval.

C. Provide point-by-point calculations for areas served by proposed fixture. Coordinate requirements with the Architect.

1.6 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

B. Comply with ANSI C2.

C. Listing and Labeling: Provide fixtures and accessories specified in this Section that are listed and labeled for their indicated use and installation conditions on Project.

1. Special Listing and Labeling: Provide fixtures for use underwater that are specifically listed and labeled for such use. Provide fixtures for use in hazardous (classified) locations that are listed and labeled for the specific hazard.
2. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

D. Fixtures for Hazardous Locations: Conform to UL 844. Provide units that have Factory Mutual Engineering and Research Corporation (FM) certification for indicated class and division of hazard.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty signed by manufacturer and Installer agreeing to replace external parts of lighting fixtures exhibiting a failure of finish as specified below. This warranty is in addition to, and not a limitation of, other rights and remedies the Owner may

have under the Contract Documents.

1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.
2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products specified in each Exterior Lighting Unit Schedule on the drawings.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp edges, and corners.

B. Sheet Metal Components: Corrosion-resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.

C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed fixtures.

D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.

E. Exposed Hardware Material: Stainless steel.

F. Reflecting Surfaces: Minimum reflectances as follows, except as otherwise indicated:

1. White Surfaces: 85 percent
2. Specular Surfaces: 83 percent
3. Diffusing Specular Surfaces: 75 percent

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

H. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.

I. Photoelectric Relays: Conform to UL 773.

1. Contact Relays: Single throw, arranged to fail in the ON position and factory set to turn light unit on at 1.5 to 3 foot-candles (16 to 32 lux) and off at 4.5 to 10 foot-candles (48 to 108 lux) with 15-second minimum time delay.

2. Relay Mounting: In fixture housing.

J. Fluorescent Fixtures: Conform to UL 1570.

K. Fluorescent Ballasts: Class P, low-temperature, electromagnetic type, compatible with the lamps and lamp combinations to which connected.

1. Certification by Electrical Testing Laboratory (ETL).
2. Labeling by Certified Ballast Manufacturers Association (CBM).
3. Sound Rating: "A" rating, except as otherwise indicated.
4. Voltage: Match connected circuits.
5. Minimum Power Factor: 90 percent.
6. Total Harmonic Distortion (THD) of Ballast Current: Less than 20 percent.
7. Conform to FCC Regulations Part 15, Subpart J for electromagnetic interference.
8. Conform to IEEE C62.41, Category A, for resistance to voltage surges for normal and common modes.
9. Minimum Starting Temperature: Minus 20 deg C.

L. High-Intensity-Discharge (HID) Fixtures: Conform to UL 1572.

M. HID Ballasts: Conform to UL 1029, and ANSI C82.4. Constant wattage autotransformer (CWA) or regulating high-power-factor type, unless otherwise indicated.

1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
2. Operating Voltage: Match system voltage.
3. Single-Lamp Ballasts: Minimum starting temperature of minus 30 deg C.
4. Open circuit operation will not reduce average life.
5. High-Pressure Sodium (HPS) Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.
6. Noise: Uniformly quiet operation, with a noise rating of B or better.

N. Instant Restrike Device: Solid-state, potted module, mounted inside fixture and compatible with mogul-based HPS lamps, ballasts, and sockets up to 150 W.

1. Restrike Range: 105 to 130 VAC
2. Maximum Voltage: 250 V peak or 150 VAC RMS

O. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp when fixture is initially energized and when momentary power outages occur. Turns quartz lamp off automatically when HID lamp reaches approximately 60 percent light output. Mount control components internal to ballast and independent of incoming line voltage.

P. Incandescent Fixtures: Conform to UL 1571.

Q. Lamps: Comply with ANSI C78 series that is applicable to each type of lamp. Provide fixtures with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a fixture, provide medium wattage lamp recommended by manufacturer.

2.3 FIXTURE SUPPORT COMPONENTS

A. Mountings, Fastenings, and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

2.4 FINISHES

A. Metal Parts: Manufacturer's standard finish, except as otherwise indicated, applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

B. Other Parts: Manufacturer's standard finish, except as otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units plumb, square, level, and secure according to manufacturer's written instructions and approved Shop Drawings.

B. Fixture Attachment: Fasten to indicated structural supports.

C. Fixture Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution.

D. Lamp fixtures with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 GROUNDING

A. Ground fixtures and metal poles according to Division 26, Section 26 0526, Grounding and Bonding for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged fixtures and components.

B. Give advance notice of dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests and Observations: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source.

E. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until all units operate properly.

3.4 ADJUSTING AND CLEANING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

3.5 EXTERIOR LIGHTING UNIT SCHEDULE

A. The luminaire schedule located in the construction drawings describes each type of luminaire for the project. Manufacturer's catalog numbers are given for convenience. Where discrepancies occur between catalog numbers and the discipline information, the descriptive information shall take precedence. Some required features, options, accessory equipment or special order requirements may not be included in the catalog number.

END OF SECTION 26 5612

SECTION 27 0500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

J. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

K. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Grout.
5. Common communications installation requirements.

1.4 GLOSSARY

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
BFU	Board of Fire Underwriters
BICSI	Building Industry Consulting Services International
CSA	Canadian Standards Association
DEC	Department of Environmental Conservation
EIA	Electronics Industry Association
EPDM:	Ethylene-propylene-diene terpolymer rubber.
ER	Equipment Room
FCC	Federal Communications Commission
FM	Factory Mutual
IEEE	Institute of Electrical and Electronics Engineers
ISD	Information Systems Division
ISO	International Standards Organization
LB	Electrical Elbow with accessible coverplate
NBR:	acryloNitrile-Butadiene Rubber.
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
RUS	Rural Utility Service (formerly REA)
TIA	Telecommunications Industry Association
UFBC	Uniform Fire Prevention and Building Code
UL	Underwriter's Laboratories, Inc.

1.5 DEFINITIONS

A. Throughout the specifications, abbreviations may be used. The following are brief definitions of many of those abbreviations.

1. Approved / Approval: Written permission to use a material or system.
2. As Called for: Materials, equipment including the execution specified/shown in the Specifications.

3. Code Requirements: Minimum requirements.
4. Concealed: Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
5. Exposed: Work not identified as concealed.
6. Final Acceptance: Owner acceptance of the project from Contractor upon certified by Owner's Representative.
7. Furnish: Supply and deliver to installation location.
8. Furnished by Others: Receive delivery at job site or where called for and install.
9. Inspection: Visual observations by Owner or Owner's Representative.
10. Install: Mount and connect equipment and associated materials ready for use.
11. Listed: Refers to classification by a standards agency.
12. Or Approved Equal: Approved equal or equivalent as determined by Owner or Owner's Representative.
13. Owner's Representative: Design professional or Consultant representing the Owner.
14. Provide: Furnish, install and connect ready for use.
15. Relocate: Disassemble, disconnect and transport equipment to new locations; then clean, test and install ready for use.
16. Replace: Remove and provide new item.
17. Review: A general contractual conformance check of specified products.
18. Satisfactory: As specified in Specifications.

1.6 SUBMITTALS

A. Product Data: For sleeve seals.

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Other approved equal

2. Sealing Elements: interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
3. Pressure Plates: Include two for each sealing element.
4. Connecting Bolts and Nuts: Of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FIRE STOPPING

A. Fire stopping for openings through fire-rated and smoke-rated walls and floor assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire

Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire Stops" designated ASTM E814.

B. Inside of all conduits, the fire stop system shall consist of dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal wire/cable movement without being displaced.

C. All conduit and sleeve openings used by the Contractor shall be waterproofed or fireproofed in compliance with State and Local Building and Fire Codes. Strict adherence to National, State, and Local Fire Codes, particularly fire stopping will be required.

D. The Contractor shall patch all openings remaining around and inside all conduit, sleeves and cable penetrations to maintain the integrity of any fire rated wall, ceiling, floor, etc. The fire stop system shall consist of a dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal wire/cable movement without being displaced.

E. All building conduits and sleeves installed and/or used under this Specification shall be fire stopped, or re-fire stopped, upon cable placement through such passageways.

F. Manufacturer's recommended installation standards must be closely followed (i.e. minimum depth of material, use of ceramic fiber and installation procedures).

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 4 inches (100 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work. Prior to installation, verify existing warranty of roof with CNM ITS and Plant Facility personnel.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals. Ensure installed sleeve is sloped towards outside to prevent rain/snow water seepage through pipe.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Fire stopping for Openings through Fire and Smoke Rated Wall and Floor Assemblies:

1. Provide materials and products listed. The system shall meet the requirements of "Fire Tests of Through-Penetration Fire Stops" designated ASTM E814. To be used inside all conduits and sleeves. Caulk on exterior of conduit penetration.
2. Provide fire stop system seals at all locations where conduit, fiber, cable trays, cables/wires and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire stop seal between sleeve and wall for drywall construction.
3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire stop system. The installation shall provide an air and watertight seal.
4. The methods used shall incorporate qualities that permit the easy removal or addition of conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating. Typical rating:

    a. floors - 3 hours
    b. corridor walls - 2 hours
    c. offices - ¾ hour
    d. smoke partitions - ¾ - 1 hour

5. Provide fire stop pillows for existing cable tray penetrations through firewalls.

END OF SECTION 27 0500

SECTION 27 0526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0528 Pathways for Communication Systems.

C. Division 27, Section 27 0536 Cable Trays for Communications Systems.

D. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbar.
4. Grounding rods.
5. Grounding labeling.

1.4 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.6 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For Installer, installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agencies field supervisor.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

1.9 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.

2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements. Provide products by one of the following available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor and 1/4 inch, (6.3 mm), in diameter.
5. Bonding Conductor No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solder-less compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch, (15.8- or 25.4-mm), centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches, (6.3 by 100 mm), in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA/EIA-607-B.

1. Predrilling shall be for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50mm), in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467 and shall comply with TIA/EIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch, (50-mm), clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards and impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbar: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467 and complying with TIA/EIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches, (1827 or 914 mm long, with), stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Harger Lightning and Grounding.
2. Tyco Electronics Corp.

B. Ground Rods: Copper-clad, Zinc-coated, Stainless steel, sectional type, 3/4 inch by 10 feet, (19 mm by 3 m), 5/8 by 96 inches, (16 by 2400 mm), in diameter.

2.6 LABELING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brother International Corporation.
2. HellermannTyton.
3. Panduit Corp.

B. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives and inks used by label printers.

C. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA/EIA-607-B.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned- copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm.)

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.
4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMBG and the ac service equipment ground shall not be smaller than No. 3/0AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches, (50 mm), minimum from wall and 12 inches, (300 mm), above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs and the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot, (1 sq. mm/linear meter), of conductor length and up to a maximum size of No. 3/0 AWG 168 kcmils, (85 sq. mm), unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted or vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB utilizing No. 6 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-C.1 and TIA/EIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "ts-TMGB," where "ts" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "ts-TGB," where "ts" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended in the BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 27 0526

SECTION 27 0528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0536 Cable Trays for Communications Systems.

D. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
2. Section 28 0528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.
3. Section 27 0536 “Cable Trays for Communication Systems”

1.4 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Tele-power poles.
4. Boxes, enclosures, and cabinets.
5. Underground handholes and boxes.

B. Sustainable Design Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

1.6 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

B. EMT: Comply with ANSI C80.3 and UL 797.

C. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions, where installed and including flexible external bonding jumper.

D. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies and compounded for use to lubricate and protect threaded conduit joints from corrosion, to enhance their conductivity.

E. Flexible Conduit will not be permitted.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
2. Comply with TIA-569-C.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Continuous HDPE: Comply with UL 651B.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum riser or general-use installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

2.4 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-C.

D. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B- Line System #781011 04762
   #781011 04874
   #781011 04770
   #781011 04875
2. Erico Caddy Cat HP System
3. Erico Caddy Cat CM System
4. Owner or Consultant approved equal.

E. Galvanized or stainless steel.

F. J shape.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-C.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

B. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy aluminum, Type FD, with a gasketed cover.

C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

D. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable, Semi-adjustable.
3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) or 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).

H. Gangable boxes are prohibited.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Coordinate "Hinged-Cover Enclosures" Paragraph below with Drawings if hinged cover enclosures other than NEMA 250, Type 1 are required, such as for very dusty areas; or if consideration should be given to use of NEMA 250, Type 3R or Type 12 enclosures.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 and Type 12, (dependent on environmental conditions), with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or fiberglass, finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1, Type 3R, Type 12, (dependent on environmental conditions), galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

2.6 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Christy Concrete Products.
2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast Group.
4. Rinker Group, Ltd.
5. Riverton Concrete Products.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Retain one of four "Frame and Cover" subparagraphs below; revise to specify features of frame and cover assembly. Consult manufacturers for additional frame and cover designs.
2. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
4. Cover Legend: Molded lettering, "COMMUNICATIONS."
5. Configuration: Units shall be designed for flush burial and have closed bottom with centered 12” diameter hole for drainage.
6. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension shall provide increased depth of 12 inches (300 mm).

b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

7. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
8. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

9. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

10. Handholes 48 inches wide by 48 inches long (1200 mm wide by 1200 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
3. Comply with TIA-569-C.
4. Handholes/Manholes shall be traffic rated when installed in parking lots, access roads and streets.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open, closed, integral closed, bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "COMMUNICATIONS."

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: EMT, RNC, Type EPC-40-PVC, RNC and Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: EMT, RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC Type EPC-80-PVC, direct buried concrete encased.
4. Boxes and Enclosures, above ground: NEMA 250, Type 3R Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT, RNC identified for such use.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT RNC, Type EPC-40-PVC or inner duct.
4. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT.
5. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway. Riser-type, communications-cable pathway EMT.
6. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway Riser-type, optical-fiber-cable pathway. Plenum-type, optical-fiber-cable pathway. General-use, communications-cable pathway. Riser-type, communications-cable pathway. Plenum-type, communications-cable pathway. EMT.
7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1 inch (27mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, steel and cast-metal fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F, (49 deg**.** C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-C for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 1 inch, (25 mm), of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

H. Stub-ups to Above Recessed Ceilings:

1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

M. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.

N. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.

O. "Pathways for Optical-Fiber and Communications Cable" Paragraph below is applicable for EMT, RMC, RNC, and optical-fiber and communications-cable pathways.

P. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:

1. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.

Q. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.

R. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

S. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg. F, (17 deg. C) and that has straight-run length that exceeds 25 feet, (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg. F, (55 deg. C) and that has straight-run length that exceeds 100 feet, (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg. F, (70 deg. C), temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg. F, (86 deg. C), temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg. F, (70 deg. C), temperature change.
    d. Ceilings and Attics: 135 deg. F, (75 deg. C), temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg. F, (0.06 mm per meter of length of straight run per deg. (C), of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg., F, (0.0115), mm per meter of length of straight run per deg., (C), of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

T. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

U. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

V. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 4 feet (1.5 m) o.c.
5. Provide a hook at each change in direction.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 2000 "Earth Moving" for pipe less than 6 inches, (150 mm), in nominal diameter.
2. Install backfill as specified in Section 31 2000 "Earth Moving."
3. After installing conduit, backfill and compact. After placing controlled backfill to within 12 inches, (300 mm), of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 2000, "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches, (75 mm), of concrete for a minimum of 12 inches, (300 mm), on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches, (1500 mm), from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch, (25 mm), above finished grade.

C. Install handholes with bottom below frost line, in accordance with manufacturer's specifications.

D. Field cut openings for conduits according to enclosure manufacturer's written instructions.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 0544, "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413, "Penetration Firestopping."

3.7 SPECIAL CONDITIONS

A. All Animal Holding, Behavior and Anterooms device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling of floor surface shall be sealed. All wiring shall be provided in either threaded RGS, IMC (when recessed), or electrical metallic tubing when recessed and with compression fittings. Once wiring is installed, the wiring shall be surrounded by a one inch barrier of silicone caulking around the conductors within the device box hub. Gasketed device cover plates shall be used, with an additional continuous bead of silicone caulk between the device plate and the adjacent wall, ceiling, or floor surface. Where device boxes and conduits are surface mounted, and where the device box meets the wall, ceiling, or floor surface, a continuous bead of silicon caulk shall be provided. Nonrecessed conduits are then required to be threaded RGS on minimum ¾: standoffs, or if also surface mounted, both sides of the conduit shall be sealed to adjacent surfaces with silicone caulk. This prevents vermin harborage in and transmission through the electrical systems.

3.8 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 0528

SECTION 27 0536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section

1.2 SUMMARY

A. Section Includes: Contractor is responsible for providing and installing a complete Cable tray system that meets or exceeds the specifications listed below.

1. Ladder cable trays, Contractor is to install cable trays within the ER/TR's.
2. Wire-basket cable trays. Contractor is to install all cable trays outside of the ER/TR,s

B. Related Requirements:

1. Section 26 0536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to sides of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

1.6 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5, 1.0.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. CPI Chatsworth, Contractor Provided

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: as indicated on Drawings.
3. Straight Section Lengths: 10 feet (3.0 m) except where shorter lengths are required to facilitate tray assembly.
4. Rung Spacing: 9 inches (225 mm)o.c.
5. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
7. No portion of the rungs shall protrude below the bottom plane of side rails.
8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
9. Class Designation: Comply with NEMA VE 1, Class 5A, Class 8A
10. Splicing Assemblies: Bolted type using serrated flange locknuts.
11. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

   a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
   b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
   d. Finish: Powder-coat enamel paint.

      1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.

      2) Hardware: Chromium-zinc plated, ASTM F 1136 or Stainless steel, Type 316, ASTM F 593 and ASTM F 594.CPI or owner and consultant approved equal

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: no greater than 12” o.c.
3. Radius-Fitting Rung Spacing: at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a concentrated load, when tested according to NEMA VE 1.
7. Load capacity: 132 lb/ft with support every 5', (200 kg/m with support every 1.5 m) Straight Section Lengths: except where shorter lengths are required to facilitate tray assembly.

8. Width: 18 inches, (457.2mm), unless otherwise indicated on Drawings.
9. Fitting Minimum Radius: , dependent on cable tray sized used
10. Class Designation: Comply with NEMA VE 1, Class 12B, Class 12C, Class 20B, and Class 20C..
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 Steel, zinc plated according to ASTM B 633.
13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 WIRE-BASKET CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. CPI Chatsworth, Contractor Provided

B. Description:

1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
2. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
3. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
5. Class Designation: Comply with NEMA VE 1, Class 8A.
6. Splicing Assemblies: Bolted type using serrated flange locknuts.
7. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.

1) Hardware: Galvanized, ASTM B 633 or Chromium-zinc plated, ASTM F 1136 or Stainless steel, Type 316.

e. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.

2) Hardware: Chromium-zinc plated, ASTM F 1136 or Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch, (40-mm-), high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, and bonding.

C. Fasten cable tray supports to building structure and install seismic restraints.

D. Design fasteners and supports to carry cable tray, the cables and a concentrated load of 200 lb., (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548, "Vibration and Seismic Controls for Electrical Systems."

E. Support wire-basket cable trays with, trapeze hangers. Center support will not be accepted.

F. Support: trapeze hangers for wire-basket trays with 3/8-inch, (10-mm-), diameter rods.

G. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

H. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1, NEMA VE 2. Space connectors and set gaps according to applicable standard.

I. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

J. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

L. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

M. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with Velcro; tie wraps shall not be used. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

C. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 60 inches (1524 mm).

D. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable

tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 0536

SECTION 27 0544 - SLEEVES & SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS & CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

1.5 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.8 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.9 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.
3. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

B. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

C. Source quality-control reports.

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch, (0.6-mm), minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches, (1270 mm) and with no side larger than 16 inches, (400 mm), thickness shall be 0.052 inch, (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches, (1270 mm), or more and one or more sides larger than 16 inches, (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM, Nitrile, (Buna N), rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel, Plastic, Stainless steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel with length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Presealed Systems.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall be used in accordance with manufacturer’s guidelines.
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

2.5 FIRESTOP

A. Furnish and install re-enterable UL listed fire rated assemblies through fire rated partitions, walls and floors. Installed per manufacturer and UL system assembly requirements.

B. Acceptable Manufacturers

1. STI (Specified Technologies Inc.)

C. Fire Rated Cable Pathways: STI EZ-PATH modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:

1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway.

a. Do not exceed manufacturer’s fill ratio recommendations.

D. Where a mechanical UL listed device/assembly is not practical to install, openings within floors and walls to accommodate communications cabling shall be provided with a re-enterable product that do not dry or cure.

E. Cable Trays are not permitted to penetrate rated wall assemblies.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

    a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm), annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed, or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel, cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SPECIAL CONDITIONS

A. All first floor Animal Holding, Behavior and Anterooms device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling of floor surface shall be sealed. All wiring shall be provided in either threaded RGS, IMC (when recessed), or electrical metallic tubing when recessed and with compression fittings. Once wiring is installed, the wiring shall be surrounded by a one inch barrier of silicone caulking around the conductors within the device box hub. Gasketed device cover plates shall be used, with an additional continuous bead of silicone caulk between the device plate and the adjacent wall, ceiling, or floor surface. Where device boxes and conduits are surface mounted, and where the device box meets the wall, ceiling, or floor surface, a continuous bead of silicon caulk shall be provided. Nonrecessed conduits are then required to be threaded RGS on minimum ¾: standoffs, or if also surface mounted, both sides of the conduit shall be sealed to adjacent surfaces with silicone caulk. This prevents vermin harborage in and transmission through the electrical systems.

END OF SECTION 27 0544

SECTION 27 0553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

B. It is the intent to create a Class 3 system of administration as per ANSI/TIA/EIA 606-A Standards. As such, all elements must be labeled with unique identifiers as described in the following sections.

C. This section includes minimum requirements for the following:

1. Labeling Communications Cabling
2. Labeling Closet Hardware
3. Labeling Work Stations

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

PART 2 - PRODUCTS

2.1 LABELS

A. The size, color and contrast of all labels should be selected to ensure that the identifiers are easily read.

B. All labels are to be mechanically printed, no hand printed labels allowed for any component.

C. Labels should be visible during the installation of and normal maintenance of the infrastructure. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat or ultraviolet light) and should have a design life equal to or greater than that of the labeled component.

D. Provide vinyl substrate with a white printing area and black print. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.

E. Labels shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.

F. Labels shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing.

PART 3 - EXECUTION

3.1 LABELING INSTALLATION

A. Horizontal Copper Cable Labeling:

1. All horizontal cables shall be labeled with self-laminating marking tape, Brady ID-Pro labeler, Panduit LS7 labeler, or equivalent labeling system. Identification shall be as follows:
2. At the TR end, the cables shall be labeled with the location of where the other end of the cable is terminated including room number, TO number, and jack position. Place label on a visible part of cable within 12” of termination point for ease of identification after termination.

    a. Example: A cable going to room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.

3. At the TO end, the cables shall be labeled 4” from termination with the following: TR – Rack.Patch Panel.Port. This shall be visible by removing outlet cover plate.

    a. Example: TR Room 114, rack 1, patch panel 1, port 03 would be: 114 – 1.1.03
    b. For voice cabling in older building with separate voice closets and no patch panels, include the TR and as much information as practical such as column, row, block number, and port number or pairs.

1) Example: TR room 105, on a 110 block in the first column, third row down, port 4 would be: 105-1.3.04

2) Example: TR room 105, no discernable pattern of columns or rows or ports, and/or mixed environment of 110 and 66 blocks, the label could be: 105 - E wall – 51/54.

B. Telecommunications Outlet (TO) Labeling Scheme:

1. TO's are labeled alphanumerically in a clockwise rotation around the room. Typically, the first TO located to the left of the main entrance of the room is labeled 1A, followed by 2A, 3A, etc. Where two entrances are present, designate one as the main entrance and label accordingly.

   a. The intent is to have unique identification for each TO. The starting point and nomenclature of the TO's are irrelevant to the location inside the room.

2. Floor box TO's are to be prefaced with "FB" to read FB1A, FB2A, etc.
3. Wireless Access Point TO's in ceilings are to be prefaced with "W" to read W1A, W2A, etc.
4. On subsequent TO installations, the TO will be labeled alphanumerically depending on where the new TO is. If the new TO is between 1A and 2A, the new TO would be labeled as 1B. If another one is later added between 1B and 2A, it would be labeled 1C. If it is after the last TO in the room, 3A, it would be labeled 4A.
5. Seek clarification from Design Team for any labeling issues that arise.

C. Faceplate Labels:

1. Faceplates will be labeled using the plastic insert to cover a printed identification tag. Each of the 2 labels in a faceplate are meant to have 2 lines for a total of 4 individual lines per faceplate.
2. The TO label will vary slightly depending on whether a unified cabling platform is used where all cables go to one TR, or separate voice and data closets are used.
3. See addendum 2 for an example spreadsheet in MS Excel with dimensions for the labels.

   a. Line 1 contains the preface "D" for Data, the specific TR, rack, patch panel, and the range of ports used for termination. In case of separate voice and data closets, only the data information is conveyed here.

      1) Example: For cables going to TR Room 114, rack 1, patch panel 1, ports 3-5, line 1 would read: D.114.1.1.03/05.

   b. Line 2 also contains information regarding where cables are terminated in the closet, but is used for subsequent cable installations to that specific TO.

      1) Example: Another 3 cables were added to the same TO at a later date. For cables that go to TR Room 114, rack 3, patch panel 3, ports 22,23, and 30, line 2 would read: D.114.3.3.22/23.30.

   c. Line 3 is only used if separate voice and data closets are being used. Line 3 contains the preface "V" for Voice, the TR, and the TO number and jack position.

1) Example: For 2 cables going to voice closet 117 in the 3rd and 4th position of TO 2A, the label would be: V.117.2A3/4.

d. Line 4 is the unique identifier for the TO. It contains the Building number, the room the TO is located in, and the alphanumeric designation of the TO as per section 4.01.B.

1) Example: A TO in room building 255, room 114, designated as 2A would be: 255-114-2A.

D. Horizontal 110 and 66 Block Labeling for voice:

1. For 110 blocks, if the cables are for room terminations, label the appropriate corresponding space for the port with the room number, TO, and jack position.

a. Example: A cable going to room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.

2. For 66 type blocks, if the cables are for room terminations, tag the cable with the room number, TO, and jack position with a loose paper tag that is easily accessible and readable.

a. Example: A cable in room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.

3. If the 110 block is for the tie cable between the voice patch panel in the rack and the wallboard, label the space corresponding to the port with the rack, patch panel and port information as per section 4.01.E.2. For tie cables between the rack and wallboard a 110 block should always be used.

a. Example: Rack 1, patch panel 1, port 03 would be: 1.1.03

E. Patch Panel Labeling:

1. For station cabling going to a TO, label each port on the patch panel with the room number, TO, and jack position.

a. Example: A cable in room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.
b. Example: A cable going to a floor box TO labeled FB1A in room 114 in the second jack position would be labeled as: 114-FB1A2

2. For voice patch panels connected to a 110 block within the TR, label each port on the voice patch panel with the corresponding 110 block source information as per section 4.01.D.3.

a. Example: A 110 block in the first column, third row down, port 4 would be: 1.3.04

F. Vertical/Riser/Intrabuilding Copper Cable Labeling:

1. All riser cables shall be labeled with self-laminating marking tape, Brady ID-Pro labeler, Panduit LS7 labeler, or equivalent labeling system.

2. At the TR, the copper riser cables shall be labeled with from/to, cable type (C for copper), cable number, and count information on both ends. Place label on a visible part of cable close to wiring block for ease of identification after termination.

    a. Example: From BDF B065 to IDF 114, first of 2, 50 pair cables would be: B065 – 114 – C01, 1-50. The second 50 pair cable between the rooms would be B065 – 114 – C02, 51-100.

3. Label cabling every 50’ along the length of the cable in open trays, and on each side of wall penetrations.

G. Vertical/Riser/Intrabuilding Fiber Cable Labeling:

1. All riser cables shall be labeled with self-laminating marking tape, Brady ID-Pro labeler, Panduit LS7 labeler, or equivalent labeling system. Identification shall be as follows:
2. At the TR, the fiber riser cables shall be labeled with from/to, cable type (F for Fiber), and cable number on both ends. Place label on a visible part of cable close to wiring block for ease of identification after termination.

    a. Example: From BDF B065 to IDF 114, first cable, would be: B065– 114 – F01. The second fiber bundle between the rooms would be B065 – 114 – F02.

3. Label cabling every 50’ along the length of the cable in open trays, and on each side of wall penetrations.

H. Vertical/Riser/Intrabuilding 110-Block Labeling

1. At the BDF and IDF, voice riser cables are terminated on their respective 110 blocks. Label only first and last pairs on each row of 110 blocks with the matching pair count information.
2. Place the entire cable label in the center of the 110 block label as per section 4.01.F: B065 – 114 – C01, 1-50

I. Coax trunk Labeling (CATV)

1. CATV coaxial trunk cables shall be labeled at each termination point with the information indicating the location of the next termination point of the cable, such as an amplifier, DCT, splitter, or tap.

J. Vertical/Riser/Intrabuilding and Campus Fiber FDU labels

1. Labels shall indicate type of fiber (single mode or multi-mode 50 or 62.5 micron), from/to information, pair count, loss for each strand, and length of cable.

K. Interbuilding/Campus/Backbone Copper and Fiber Cable Labeling:

1. All interbuilding cables shall be labeled permanently with from/to information, cable type and size, installation date, and installing contractor at each end, manhole, and pullbox the cable passes through.

    a. Example: From Building 256 to 203, a 200 pair copper cable, installed by RMV Enterprises on September 22, 2006 would be: 256/203 – 200 Pair Copper – 9/22/06 – RMV Enterprises.

END OF SECTION 27 0553

SECTION 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. Backboards.
2. Grounding.

1.4 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

1.8 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.

2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

PART 2 - PRODUCTS

2.1 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section 06 1000 "Rough Carpentry." Use fire rated plywood. Paint all sides with two coats of fire retardant paint. Do not paint over plywood rating stamp.

2.2 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless, compression exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide, (6 mm thick by 100 mm wide), with 9/32-inch, (7.14-mm), holes spaced 1-1/8 inches, (28 mm), apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with TIA/EIA-607-B.

2.3 LABELING

A. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with site specific labeling requirements as defined by the owner

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 0544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.3 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 4 inches (150 mm) to 8 feet, 4 inches (2588 mm) above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-C.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA/EIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for all Class 3 and Class 4 level of administration, including optional identification requirements of this standard.

D. Labels shall be preprinted or computer-printed type.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-C, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 27 1100

SECTION 27 1116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. Power strips.
3. Grounding.
4. Labeling.
5. Patch Panels

1.4 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

1.8 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL listed.

B. RoHS compliant.

C. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 19-INCH EQUIPMENT RACKS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. CPI Chatsworth, Contractor Provided

B. Refer to Appendix A – Approved Parts List of NMSU Division 27 Communication Infrastructure Standards, 2020 for Approved manufacture model #s.

C. Description: Two- and four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.

D. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Finish: Manufacturer's standard, baked-polyester powder coat.

E. Floor-Mounted Racks:

1. Two-Post Load Rating: 200 lb (91 kg).
2. Four-Post Load Rating: 1000 lb (454 kg).
3. Number of Rack Units per Rack: 45

4. Threads: Universal square.
5. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
6. Base shall have a minimum of four mounting holes for permanent attachment to floor.
7. Top shall have provisions for attaching to cable tray or ceiling.
8. Self-leveling.

F. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Coordinate with NMSU ICT for Power Strip configuration.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
8. Cord connected with 15-foot (4.5-m) line cord.
9. Rocker-type on-off switch, illuminated when in on position.
10. Peak Single-Impulse Surge Current Rating: 13 kA per phase.
11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal TGB: Designed for mounting in 19-inch (482.6) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

2.5 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Refer to NMSU Division 27 Standards and NMSU ICT Dept for exact requirements.

1. Coordinate with NMSU ICT prior to commencing work.

2.6 PATCH PANELS

A. Manufacturers:

1. Commscope Uniprise (SL Series)

a. 48 Port Angled – CPPA-UDDM-SL-2U-48 760-237-043
b. 48 Port Flat – CPP-UDDM-SL-2U-48 760-237-04

2. Substitutions: Only by prior approval from NMSU ICT.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches (50 mm) of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 4 level of administration.

D. Labels shall be machine printed. Type shall be 1/8 inch (3 mm) in height.

END OF SECTION 27 1116

SECTION 27 1300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable – contractor provided
3. Fiber Optic Cable – Intra-building Fiber – 24 count SM MIC plenum. Corning Part # 024E88-33131-29. Inter-building Fiber - 48 count SM LT Altos. Corning Part # 048EU4-T4101D20
4. Cabling identification products.

1.4 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.5 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.6 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-C.1, when tested according to test procedures of this standard.

1.7 ACTION SUBMITTALS

A. Product Data: Submit for each type of product indicated.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.

c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector. (See 1.10-A 1-3) Submit qualifications.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.9 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD and a full time staff member to supervise all on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

E. Grounding: Comply with TIA/EIA-607-B.

1.11 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have 5 (five) years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and 3 (three) years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a 3 (three) year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of 5 years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.13 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.14 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels. Paint all sides with two, (2), coats of fire retardant paint. Do not paint over plywood rating stamp.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Commscope / TYCO (TE Connectivity – AMP NetConnect) Contractor provided.

B. Description: 100-ohm, 25-pair UTP, formed into 25-pair binder groups covered with a thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.1 for performance specifications.
3. Comply with TIA-568, Category 3.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
b. Communications, Riser Rated: Type CMR, complying with UL 1666.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Commscope / TYCO (TE Connectivity – AMP NetConnect) Contractor provided.

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.4 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Corning Cable Systems.

B. Description: OS2 singlemode nonconductive, CMP, (indoor/outdoor, plenum rated, dependent on environmental conditions), tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C.3 for performance specifications.
3. Comply with TIA/EIA-492CAAB for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. Maximum Attenuation (dB) / km 3.5 @ 850nm / 1.5 @ 1300nm, OM 4. 0.65db/km @1310nm, 0.65db/km @ 1383nm, 0.50db/km @1550nm, OS 2
b. Minimum Modal Bandwidth OFL (MHz x km) 2000 @ 850nm / 500 @ 1300nm, OM 4. 1310, 1383, 1550 OS 2

C. Jacket:

1. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-D.
2. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Corning Cable Systems.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA-604-12. Comply with TIA-568-C.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.6 GROUNDING

A. Comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA/EIA-607-B.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-B and TIA/EIA-568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections. Cable that does not pass test and inspections shall be replaced.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceway and Boxes for Electrical Systems."
3. Contractor is to install all required cabling, terminate, and test cabling.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Contractor is to install all required cabling, terminate, and test cabling.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
8. In the communications equipment room, install a 10-foot, (3-m-), long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.2.
2. Do not untwist UTP cables more than 1/4 inch, (6.35mm), from the point of termination to maintain cable geometry.
3. Contractor is to install all required cabling, terminate, and test cabling.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches, (1524 mm), apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-C recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches, (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches, (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches, (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches, (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches, (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches, (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches, (76 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches, (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches, (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches, (127 mm).

3.3 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

B. Comply with TIA/EIA-569-C; Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA/EIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch, (50-mm), clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

1. Administration Class: 3, 4.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 09 9123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 4 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Section 27 1500 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches, (100 mm), of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet, (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with a name and number of a particular device as shown.
b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-B, for the following:

1. Cables; use flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration

4. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-B, Method B, One Reference Jumper.

2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.1.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer’s warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

END OF SECTION 27 1300

SECTION 27 1500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

1.3 SUMMARY

A. Section Includes:

1. UTP cabling, (contractor provided)
2. Cabling system identification products.
3. Cable management system.

B. Related Requirements:

1. Section 27 1300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 28 1300 "Access Control" for cabling associated with system panels and devices.

3. Section 28 1600 “Intrusion Detection” for cabling associated with system panels and devices.
4. Section 28 2300 “Video Surveillance” for cabling associated with system panels and devices.
5. Section 28 3200 “Rescue Communication Systems” for cabling associated with system panels and devices.

1.4 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: One of each type.
4. Multiuser Telecommunications Outlet Assemblies: One of each type.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA-569-C.

F. Grounding: Comply with TIA-607-B.

1.11 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-C.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Contractor is to install all required cabling, terminate, and test cabling.

B. A work area is approximately 100 sq. ft., (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet, (90 m). This maximum allowable length does not include an allowance for the length of 16 feet, (4.9 m), to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C.1 when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Grounding: Comply with TIA/EIA-607-B.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Commscope / TYCO (TE Connectivity – AMP NetConnect) Contractor provided.

B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-C.1 for performance specifications.
3. Comply with TIA/EIA-568-C.2 Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Commscope / TYCO (TE Connectivity – AMP NetConnect) Contractor provided.

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA-568-C.1.

B. Workstation Outlets: Two or Four-port-connector assemblies (as shown in drawings) mounted in single or multigang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

C. Animal Research Spaces

1. Device boxes in animal research spaces require cast boxes with external hub and gasketed device cover plate and specific silicone caulking.

2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-B and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA/EIA-568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Install “wet” rated cable when the voice and data cabling conduit pathway is in the slab or underground. Transition “wet” rated cable to plenum if pathway extends into a plenum space without conduit. Wet rated cable shall not be installed in the open plenum ceiling space.
3. Comply with requirements in Section 270528 "Pathways for Communications Systems."
4. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
5. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Contractor is to install all required cabling, terminate, and test cabling.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
8. In the communications equipment room, install a 10-foot, (3-m), long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.2.
2. Do not untwist UTP cables more than 1/4 inch (6.35 mm) from the point of termination to maintain cable geometry.
3. Contractor is to install all required cabling, terminate, and test cabling.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.3.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches, (200 mm), above ceilings by cable supports not more than 60 inches, (1524 mm), apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-C for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

H. Protect cabling during installation:

1. Protect voice and data cabling cables from any liquid, paints, solvents, debris, or other contaminates, per the manufacturers installation guidelines. Cables shall be replaced if damaged.

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

B. Comply with TIA-569-C; Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding and Electrical Protection" Chapter.

B. Comply with TIA/EIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch, (50-mm), clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

1. Administration Class: 3, 4, TIA/EIA-606-B.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 09 9123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 4 level of administration, including optional identification requirements of this standard.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-B. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches, (100 mm), of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet, (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device, shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-B.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.1.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer’s warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

END OF SECTION 27 1500

SECTION 27 1543 – COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

B. This section includes minimum requirements for the following:

1. Faceplates
2. Connectors

1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

J. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

PART 2 - PRODUCTS

2.1 FACEPLATES

A. Standard faceplates are CommScope Uniprise SL Series faceplates and inserts or 110Connect single and double gang faceplates –either type is acceptable – standard faceplate color is almond,

standard insert color is orange. Communications outlets are typically within 3 feet of an electrical outlet and installed at the same height, unless otherwise specified. Communications outlets should be placed so that the work area or workstation cable does not exceed 5 meters (16 ft) in length. This length is figured into the total horizontal cabling length and must not be exceeded. All labels are to be mechanically printed, no hand printed labels allowed for any component.

2.2 CONNECTORS

A. All modular jacks shall be un-keyed, unshielded, 4-pair, RJ-45, and shall fit in a .790" X .582" opening. Modular jacks shall terminate using 110-style pc board connectors, color-coded for both T568A and T568B wiring. Each modular jack shall be wired to T568B. The 110-style insulation displacement connectors shall be capable of terminating 22-24 AWG solid or 24 AWG stranded conductors. The insulation displacement contacts shall be paired with additional space between pairs to improve crosstalk performance. Modular jacks shall utilize a secondary PC board separate from the signal path for crosstalk compensation. Each modular jack shall meet the Category 6 or 6A performance standards and the requirements. The jack color will be orange unless otherwise specified.

B. Modular jacks shall be compatible with the CommScope Uniprise SL Series Modular Jack Termination Tool part number 1725150-1. Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination. Modular jacks shall be UL Listed under file number E81956. See approved parts list at end of document.

PART 3 - EXECUTION

3.1 GENERAL

A. This Section describes the installation locations for the products and materials, as well as methods and NMSU IT Standards associated with the Telecommunications Installation portions of the Project. These Specifications, along with the drawings and other NMSU IT supplied specifications shall be followed during the course of the installation.

B. The contractor is required to be currently listed as an approved manufacturer registered Certified Installer and provide personnel for telecommunications installations who are certified and meet warranty requirements established by the manufacturer.

C. The Contractor is instructed to coordinate his efforts with the other tradesmen who may be working within the same vicinity to avoid conflict and lost time.

D. The Contractor is required to supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.

E. The Contractor shall verify space requirements and locations with NMSU IT prior to starting cable installations and terminations.

F. All terminations are to use TIA T568B wiring standards.

G. Terminate according to the manufacturer's instructions.

3.2 TERMINATIONS

A. Twisted pair cable.

1. All twisted pair cable shall be terminated as described by the manufacture with the proper tools.

B. Coax Cable

1. All Coax cable shall be terminated using connectors matching cable type and application, tool assembly matching connector type for crimp or compression type connectors and follow Manufacturer procedures for termination.

C. Optical Fiber Cable

1. Optical Fiber terminated at the desk top will be with LC connectors following manufacture procedure. Optical fiber terminated in TR/ER's shall be fusion type LC connectors or fusion spliced pigtails using LC connectors when specified, on all new projects, existing projects where optical fiber is being added confirm in writing connector type with NMSU IT.

3.3 EQUIPMENT INSTALLATION AND CABLE TERMINATIONS

A. All equipment shall be installed in a neat and workmanlike manner, arranged for convenient operation, testing and future maintenance.

B. All telecommunications cables, faceplates, and connectors shall be installed and terminated by manufacturer certified technicians experienced in the installation and termination of telecommunications items listed herein.

C. The contractor shall provide manufacturer certified technicians and installers per all the requirements of the current on call contractor RFP.

3.4 SPECIAL CONDITIONS

A. All Animal Holding, Behavior and Anterooms device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling of floor surface shall be sealed. All wiring shall be provided in either threaded RGS, IMC (when recessed), or electrical metallic tubing when recessed and with compression fittings. Once wiring is installed, the wiring shall be surrounded by a one inch barrier of silicone caulking around the conductors within the device box hub. Gasketed device cover plates shall be used, with an additional continuous bead of silicone caulk between the device plate and the adjacent wall, ceiling, or floor surface. Where device boxes and conduits are surface mounted, and where the device box meets the wall, ceiling, or floor surface, a continuous bead of silicon caulk shall be provided. Nonrecessed conduits are then required to be threaded RGS on minimum ¾: standoffs, or if also surface mounted, both sides of the conduit shall be sealed to adjacent surfaces with silicone caulk. This prevents vermin harborage in and transmission through the electrical systems.

3.5 AS-BUILT INFORMATION

A. Contractor shall provide 1 set of preliminary as-built information to NMSU IT along with all test result information 2 weeks prior to occupancy or substantial complication. Partial as-builts shall be submitted as cabling is completed. A final as-built shall be submitted with all corrections made a maximum of 30 days after cabling installation is complete.

B. As-built information shall be in electronic PDF format. Indicate location of all TOs, pathways, distribution cable trays, junction boxes, and all additions and deletions pertaining to telecommunications. Include correct TO labeling next to all telecom symbols.

C. If construction drawings are not utilized, contractor shall provide all telecommunications location information on an accurate and scaled floor plan.

3.6 WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide floor plans showing locations of all telecommunication outlets and spaces.

D. Contractor shall perform these requirements for category 6 and 6A permanent link configurations and submit to the hardware manufacturer such paperwork and test results as necessary to obtain a minimum 20-year system performance guarantee to NMSU as defined by the cable and hardware manufacturers. The 20-year minimum system warranty shall be provided to NMSU IT.

END OF SECTION 27 1543

SECTION 28 0526 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.

1.3 DEFINITIONS

A. Signal Ground: The ground reference point designated by manufacturer of the system that is considered to have zero voltage.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.2 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

C. Basis-of-Design Product:

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

D. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

E. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. Grounding Busbars: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.)
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm long), with stainless-steel or copper-plated hardware for attachment to the rack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Bond shields and drain conductors to ground at only one point in each circuit.

B. Signal Ground:

1. For each system, establish the signal ground and label that location as such.
2. Bond the signal ground to the alternating-current (ac) power system service by connecting to one of the following listed locations, using insulated No. 6 AWG, stranded, Type THHN wire:

    a. Grounding bar in an electrical power panelboard if located in the same room or space as the signal ground.
    b. Telecommunications grounding busbar.

C. Comply with NECA 1.

3.2 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.

3.3 CONNECTIONS

A. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

B. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

C. Shielded Cable: Bond the shield of shielded cable to the signal ground. Comply with TIA/EIA-568-C.1 and TIA/EIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

D. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 28 0526

SECTION 28 0528 - PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetallic conduits, tubing, and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 26 0533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
3. Section 27 0528 "Pathways for Communications Systems" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving communications systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: For wireways, nonmetallic wireways and surface pathways and for each color and texture specified, 12 inches (300 mm) long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Alpha Wire Company.
4. Anamet Electrical, Inc.
5. Electri-Flex Company.
6. O-Z/Gedney.
7. Picoma Industries.
8. Republic Conduit.
9. Robroy Industries.
10. Southwire Company.
11. Thomas & Betts Corporation.
12. Western Tube and Conduit Corporation.
13. Wheatland Tube Company.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit, IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corporation.
7. Condux International, Inc.
8. Electri-Flex Company.
9. Kraloy.
10. Lamson & Sessions; Carlon Electrical Products.
11. Niedax-Kleinhuis USA, Inc.
12. RACO; Hubbell.
13. Thomas & Betts Corporation.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. RTRC: Comply with UL 1684A and NEMA TC 14.

I. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

J. Fittings for LFNC: Comply with UL 514B.

K. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

L. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alpha Wire Company.
2. Arnco Corporation.
3. Endot Industries Inc.
4. IPEX.
5. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum riser or general-use installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 Type 3R Type 4 Type 12, dependent on environmental conditions, unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type, Screw-cover type or Flanged-and-gasketed type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Allied Moulded Products, Inc.
2. Hoffman.
3. Lamson & Sessions; Carlon Electrical Products.
4. Niedax-Kleinhuis USA, Inc.

B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

C. Description: Fiberglass polyester extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. Hoffman.
6. Lamson & Sessions; Carlon Electrical Products.
7. Milbank Manufacturing Co.
8. Molex.
9. Mono-Systems, Inc.
10. O-Z/Gedney.
11. Quazite:Hubbell Power Systems, Inc.
12. RACO; Hubbell.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-C.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy aluminum, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable, Semi-adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a q
5. Shape: Rectangular. Qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum, galvanized, cast iron with gasketed cover.

J. Device Box Dimensions: 4-inches square by 2-1/8 inches deep (100 mm square by 60 mm deep), 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).

K. Gangable boxes are prohibited.

L. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 and Type 12, (dependent on environmental conditions), with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

a. Material: Plastic, Fiberglass.

b. Finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:

1. NEMA 250, Type 1, Type 3R and Type 12, (dependent on environmental conditions), galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-C.
4. Handholes/Manholes shall be traffic rated when installed in parking lots, access roads and streets.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. NewBasis.
d. Oldcastle Precast, Inc; Christy Concrete Products.

2. Standard: Comply with SCTE 77.

3. Configuration: Designed for flush burial with open, closed, integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".

7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC, IMC, RNC, Type EPC-40-PVC, RNC, Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: GRC, IMC, EMT, RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, Type EPC-80-PVC, direct buried concrete encased.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC, LFNC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT, ENT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT, RNC identified for such use.
3. Exposed and Subject to Severe Physical Damage: GRC, IMC. Pathway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT, ENT or RNC, Type EPC-40-PVC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC, IMC.
7. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT.
8. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway, Riser-type, communications-cable pathway, EMT.
9. Pathways for Concealed General Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway, Riser-type, optical-fiber-cable pathway, Plenum-type, optical-fiber-cable pathway, General-use, communications-cable pathway, Riser-type, communications-cable pathway Plenum-type, communications-cable pathway, EMT.

10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel, nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel, cast-metal fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F (49 deg. C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-C for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 1 inch (25 mm), 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

5. Change from ENT to RNC, Type EPC-40-PVC, GRC or IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

R. Surface Pathways:

1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points. Secure surface pathway with screws or other anchor-type devices at intervals not exceed ing 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg. F (17 deg. C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg. F (55 deg. C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg. F (70 deg. C) temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg. F (86 deg. C) temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg. F (70 deg. C) temperature change.
    d. Attics: 135 deg. F (75 deg. C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg. F (0.06 mm per meter of length of straight run per deg. C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg. F (0.0115 mm per meter of length of straight run per deg. C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain-tight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line and in accordance within manufacturer’s guidelines.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 28 0528

SECTION 28 0544 - SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
   2. Penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   1. Material: Galvanized-steel sheet.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.
   2. Sealing Elements: EPDM, Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel, Plastic, Stainless steel.
   4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Presealed Systems.

2.4 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel, cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 28 0544

SECTION 28 1300 - ACCESS CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.

1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. CPU: Central processing unit.

C. Credential: Data assigned to an entity and used to identify that entity.

D. Dpi: Dots per inch.

E. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

F. GFI: Ground fault interrupter.

G. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

H. I/O: Input/Output.

I. LAN: Local area network.

J. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

K. PC: Personal computer. Applies to the central station, workstations, and file servers.

L. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

M. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.

N. RAS: Remote access services.

O. RF: Radio frequency.

P. ROM: Read-only memory. ROM data are maintained through losses of power.

Q. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

R. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

S. UPS: Uninterruptible power supply.

T. USB: Universal serial bus.

U. WAN: Wide area network.

V. WAV: The digital audio format used in Microsoft Windows.

W. WMP: Windows media player.

X. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

Y. Windows: Operating system by Microsoft Corporation.

Z. Workstation: A PC with software that is configured for specific, limited security-system functions.

AA. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
2. Cable Administration Drawings: As specified in "Identification" Article.

C. Samples: For each exposed product and for each color and texture specified.

D. Other Action Submittals:

1. Project planning documents as specified in Part 3.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Microsoft Windows software documentation.
2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Alarm Printer Black/Red Ribbons: Package of 12.

2. Laser Printers: Three toner cassettes and one replacement drum unit.
3. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
4. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70, "National Electrical Code."

E. Comply with SIA DC-01 and SIA DC-03and SIA DC-07.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg. F (10 and 30 deg. C), and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg. F (16 to 30 deg. C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg. F (2 to 50 deg. C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Outdoor Environment: NEMA 250, NEMA 250, Type 3, Type 3R, Type 3S, Type 4 and Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg. F (minus 34 to plus 50 deg. C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h)and snow cover up to 24 inches (610 mm) thick.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1 Blackboard, Inc. – Transact, (New building shall tie into existing Blackboard Transact System)

2.2 DESCRIPTION

A. NMSU Standard – SA3000 Door Access System as manufactured by Blackboard, Inc.

B. Security Access System: PC-based central station, one or more networked PC-based workstations, and field-installed controllers, connected by a high-speed electronic-data transmission network.

C. Network connecting the central station and workstations shall be a LAN, WAN using Microsoft Windows-based TCP/IP with a capacity of connecting up to 99 workstations. System shall be portable across multiple communication platforms without changing system software.

D. Network(s) connecting PCs and controllers shall consist of one or more of the following:

1. Local area, IEEE 802.3 Fast Ethernet Gigabit-Ethernet, 100 BASE-TX, star topology network based on TCP/IP.
2. Direct-connected, RS-232 cable from the COM port of the central station to the first controller, then RS-485 cable to interconnect the remaining controllers at that Location.
3. Dial-up and cable modem connection using a standard cable or dial-up telephone line.

2.3 SYSTEM DATABASE

A. Existing Blackboard Transact System and Software

2.4 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.5 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation. Controllers are to be located in a centrally located ER/TR.

B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.

C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.

D. Alarm Annunciation Controller:

1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network, with dc line supervision on each of its alarm inputs.

    a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
    b. Alarm-Line Supervision:

        1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 5 percent or more for longer than 500 ms.
        2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.

    c. Outputs: Managed by central-station software.

2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.

E. Entry-Control Controller:

1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.

    a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
    b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:

        1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
        2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.

    c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.

2. Inputs:

    a. Data from entry-control devices; use this input to change modes between access and secure.
    b. Database downloads and updates from the central station that include enrollment and privilege information.

3. Outputs:

    a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
    c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
    d. Door Prop Alarm: If a portal is held open for longer than 20 seconds, alarm sounds.

4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.

    a. Store up to 1000 transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.

6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.

    a. Backup Battery: Premium, valve -regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata 9-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
    b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

c. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.

d. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:

1) Trouble Alarm: Normal power-off load assumed by battery.
2) Trouble Alarm: Low battery.
3) Alarm: Power off.

2.6 SECONDARY ALARM ANNUNCIATOR

A. Secondary Alarm Annunciation Site: A workstation with limited I/O capacity, consisting of a secondary alarm annunciation workstation to allow the operator to duplicate functions of the main operator interface and to show system status changes.

2.7 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Stripe Swipe Readers: Bidirectional, reading cards swiped in both directions, powered by the controller. Reader shall be set up for ABA Track.

1. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.

2. Readers for outdoors shall be in a polymeric plastic enclosure with all electronics potted in plastic. Rated for operation in ambient conditions of minus 40 to plus 160 deg F (minus 40 to plus 70 deg C) in a humidity range of 10 to 90 percent.

F. Touch-Plate and Proximity Readers:

1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
2. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
3. The card reader shall read proximity cards in a range from direct contact to at least 6 inches (150 mm) from the reader.

2.8 PUSH-BUTTON SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Securitron Magnalock Corporation; an ASSA ABLOY Group company or approved equal.

B. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless-steel switch enclosures.

C. Electrical Ratings:

1. Minimum continuous current rating of 10 A at 120-V ac or 5 A at 240-V ac.
2. Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.

D. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.

E. Enclosures shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors.

F. Power: Push-button switches shall be powered from their associated controller, using dc control.

2.9 DOOR HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Section 087100 "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Section 087100 "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Section 087100 "Door Hardware."

2.10 TIA 232-F ASCII INTERFACE SPECIFICATIONS

A. ASCII interface shall allow TIA 232-F connections to be made between the control station operating as the host PC and any equipment that will accept TIA 232-F ASCII command strings, such as CCTV switches, intercoms, and paging systems.

1. Alarm inputs in system shall allow for individual programming to output up to four unique ASCII character strings through two different COM ports on the host PC.
2. Inputs shall have the ability to be defined to transmit a unique ASCII string for alarm and one for restore through one COM port, and a unique ASCII string for a nonalarm, abnormal condition and one for a normal condition through the same or different COM port.

3. Predefined ASCII character strings shall have the ability to be up to 420 characters long with full use of all the ASCII control characters, such as return or line feed. Character strings shall be defined in the system database and then assigned to the appropriate inputs.
4. COM ports of the host PC used to interface with external equipment shall be defined in the setup portion of the software. COM port's baud rate, word length, stop bits, and parity shall be definable in the software to match that of the external equipment.

B. Pager-System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.

1. TIA 232-F output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to the paging system. This interface shall support both numeric and alphanumeric pagers.

C. Alarm-System Interface:

1. TIA 232-F output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.
2. Alternatively, alarms that are received by this access-control system are to be transferred to the alarm automation system as if they were sent through a digital alarm receiver.

a. System shall be able to transmit an individual message from any alarm input to a burglar-alarm automation monitoring system.
b. System shall be able to append to each message a predefined set of character strings as a prefix and a suffix.

2.11 FLOOR-SELECT ELEVATOR CONTROL

A. A. Elevator access control shall be integral to security access.

1. System shall be capable of providing full elevator security and control through dedicated controllers without relying on the control-station host PC for elevator control decisions.
2. Access-control system shall enable and disable car calls on each floor and floor-select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.
3. System setup shall, through programming, automatically and individually secure and unsecure each floor-select button of a car by time and day. Each floor-select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.
4. When a floor-select button is secure, it shall require the passenger to use his or her access code and gain access to that floor before the floor-select button will operate. The passenger's credential shall determine which car call and floor-select buttons are to be enabled, restricting access to floors unless authorized by the system's access code database.

Floor-select button shall be enabled only in the car where the credential holder is the passenger.

B. Security access system shall record which call button is pressed, along with credential and time information.

1. System controller shall record elevator access data.
2. The controller shall reset all additional call buttons that may have been enabled by the user's credential.
3. The floor-select elevator control shall allow for manual override from a workstation PC either by individual floor or by cab.

2.12 CABLES

A. A. General Cable Requirements: Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

B. Composit cable, Plenum Rated, consisting of the following: (Controller to Junction box at door location)

1. 4 conductor, 18 AWG shielded
2. 3 pair, 22AWG Shielded.
3. 2 conductor, 22 AWG, shielded.
4. 4 conductor, 22 AWG, shielded
5. NFPA 70, Type CMP.
6. Flame Resistance: NFPA 262 flame test.

C. Junction box to door hardware cabling;

1. See sheet E-510 for breakdown of required cabling

D. Elevator Travel Cables:

1. Steel center core with shielded, twisted pairs, No. 20 AWG conductor size.

2. Steel center core support shall be pre-formed, flexible, low-torsion, zinc-coated, steel wire rope; insulated with 60 deg C flame-resistant PVC and covered with a nylon or cotton braid.
3. Shielded pairs shall be insulated copper conductors; color-coded, insulated with 60 deg C flame-resistant PVC; each pair shielded with bare copper braid for 85 percent coverage.
4. Electrical grade, dry jute filler.
5. Helically wound synthetic fiber binder.
6. Rayon or cotton braid applied with 95 percent coverage.
7. 60 deg C PVC jacket specifically compounded for flexibility and abrasion resistance; and complying with UL VW-1 and CSA FT1 flame rated.

E. LAN Cabling:

1. Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security," And section 27 1500, “Communications Horizontal Cabling”.
2. NFPA 262.

2.13 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format using Visio or Cad.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

A. Comply with TIA 569-C, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. (15 m).

D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. (75 m) 500 ft. (150 m).

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. (8 m).

3.5 GROUNDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

A. Access Control contractor is to provide a complete “Turn-Key” installation that is tied into existing “Blackboard Transact” system.

B. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- (6.4-mm-) high text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

C. Install card readers, keypads, push buttons where required. Refer to plans for all locations.

3.7 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-B.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-C.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
4. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 28 1300

SECTION 28 1600 - INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes intrusion detection with communication links to perform monitoring, alarm, and control functions. Contractor is responsible for providing and installing a complete “turn-key” Intrusion system that meets or exceeds the specifications listed below.

B. Contractor shall coordinate with NMSU PD to confirm make/models of Intrusion Systems components prior to purchasing and submitting product information.

C. Related Sections:

1. Section 28 2300 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

1.3 DEFINITIONS

A. Control Unit: System component that monitors inputs and controls outputs through various circuits.

B. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

C. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

D. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.

E. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.

C. UPS: Sizing calculations.
1. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
2. Master Control-Unit Console Layout: Show required artwork and device identification.
3. Device Address List: Coordinate with final system programming.
4. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
5. Details of surge-protection devices and their installation.
6. Sensor detection patterns and adjustment ranges.

D. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

E. Samples: For units with factory-applied color finishes.

1.5 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have 5 (five) years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and 3 (three) years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a 3 (three) year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of 5 years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

1.6 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Warranty: Sample of special warranty

1.7 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Intrusion Detection Devices: Furnish quantity equal to five percent of the number of units of each type installed, but no less than one of each type.
2. Fuses: Three of each kind and size.
3. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no less than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International
2. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
3. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain controllers, sensors, and all software through one source from single manufacturer.

C. Testing Agency Qualifications: Member Company of NETA or an NRTL.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

F. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.

G. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to 4000 feet (1220 m).
2. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg. F (16 to 29 deg. C) and a relative humidity of 20 to 80 percent, noncondensing.
3. Interior, Controlled Environment: System components, except master control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient of 36 to 122 deg. F (2 to 50 deg. C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient of 0 to 122 deg. F (minus 18 to plus 50 deg. C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
5. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient of minus 30 to plus 122 deg. F (minus 34 to

plus 50 deg. C) dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.

6. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flying's shall be rated, listed, and installed according to NFPA 70.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Description: Hard-wired, Multiplexed, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

D. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

E. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

F. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

G. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

1. Switch selected lights.
2. Shift elevator control to a different mode.
3. Open a signal path between certain intercommunication stations.
4. Shift sound system to "listening mode" and open a signal path to certain system speakers.
5. Place’s calls to the safety director and principles once an event has transpired.

H. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

I. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

J. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

K. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

L. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT REQUIREMENTS

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 4313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

B. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

C. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

D. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

F. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

G. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

H. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.3 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, fiberglass, stainless steel.

D. Corrosion Resistant: NEMA 250, Type 4X, PVC, stainless steel.

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.4 SECURE AND ACCESS DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Honeywell, Inc; ADEMCO products
2. Tyco.
3. Owner and Consultant Approved Equal

B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

C. Key-Operated Switch: Change protected zone between secure and access conditions.

2.5 DOOR AND WINDOW SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Honeywell International Inc.; Honeywell Security.
2. Tyco
3. Owner and Consultant approved equal

B. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

D. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

2.6 PIR SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Honeywell International Inc.; Honeywell Security.
2. Tyco
3. Owner and Consultant Approved Equal

B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

C. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.

1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet (15 m). Provide adjustable coverage pattern as indicated.
2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.
3. Ceiling-Mounted Unit Pattern Size: 84-inch (2135-mm) diameter at floor level for units mounted 96 inches (2440 mm) above floor; 18-foot (5.5-m) diameter at floor level for units mounted 25 feet (7.6 m) above floor.

D. Device Performance:

1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg. F (1 deg. C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

2.7 MICROWAVE INTRUSION DETECTORS (INTERIOR)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Honeywell International Inc.; Honeywell Security.
2. Tyco
3. Owner and Consultant Approved Equal

B. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.

1. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.

2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.

2.8 MASTER CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Tyco.
2. Honeywell International Inc.; Honeywell Security.
3. Owner and Consultant Approved Equal

B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.
4. Control circuits for operation of mechanical equipment in response to an alarm.

C. Construction: Freestanding equipment rack or Desk-mounted console, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.

D. Comply with UL 609, UL 1023, UL 1076.

E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: LCD, two and three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

    a. Acknowledge alarm.
    b. Silence alarm.
    c. System reset.
    d. LED test.

6. Timing Unit: Solid state, programmable, 365 days.
7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
8. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the protected zone or addressable detector originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
9. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone or addressable detector originating the alarm appears on LED or LCD display at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.
10. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone or addressable detector originating the alarm appears on LED, LCD or cathode-ray-tube display at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.

11. Alarm activation sounds a bell or siren and strobe.

F. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

G. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

H. UPS: Comply with Section 26 3353 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.

I. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.

J. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.9 AUDIBLE AND VISUAL ALARM DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Honeywell International Inc.; Honeywell Security.
2. Tyco.

3. Owner and Consultant Approved Equal

B. Bell: Master control unit 10 inches (254 mm) in diameter, rated to produce a minimum sound output of 84 dB at 10 feet (3 m) from master control unit.

1. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

C. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet (1 m), plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.

1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

D. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from master control unit.

1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

E. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.

1. Light Output: 115 cd, minimum.
2. Flash Rate: 60 per minute.

2.10 SECURITY FASTENERS

A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acument Global Technologies North America.
2. Safety Socket LLC.
3. Tamper-Pruf Screws.

C. Drive System Types: Pinned Torx-Plus, pinned Torx or pinned hex (Allen).

D. Socket Flat Countersunk Head Fasteners:

1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

E. Socket Button Head Fasteners:

1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

F. Socket Head Cap Fasteners:

1. Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
2. Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.

G. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

PART 3 - EXECUTION

3.1 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

3.2 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Section 26 0533 "Raceways and Boxes for Electrical Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring Method: Install wiring in metal raceways according to Section 26 0533 "Raceways and Boxes for Electrical Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 28 0513 "Conductors and Cables for Electronic Safety and Security."

4. Data and Television Signal Transmission Cables: Install according to Section 28 0513 "Conductors and Cables for Electronic Safety and Security."

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 26 0553 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from master control unit.

3.4 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5 -ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

D. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation and User training."

E. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with provisions in NFPA 731, Ch. 4, "Documentation and User training." See Section 01 7900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 28 1600

SECTION 312000 -EARTHWORK

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work covered by this Section consists of furnishing all plant, labor, equipment, appurtenances and material in performing all operations, hauling, placing, spreading, watering, processing, compacting and shaping earth sections complete in place in accordance with the Project Manual and Drawings.

1.02 RELATED WORK ELSEWHERE

A. Section 31 10 00 - Clearing

B. General foundation notes on Drawings. In case of conflict or omission, the general foundation notes shall govern.

1.03 SUBSURFACE SOIL DATA

A. Subsurface soil investigations have been made and the results are available for examination by the Contractor. This is not a warranty of conditions, the Contractor is expected to examine the site and determine for himself the character of materials to be encountered.

B. No additional allowance will be made for rock removal, site clearing and grading, filling, compaction, disposal, or removal of any unclassified materials.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM).

1.	ASTM D 1556-90	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
2.	ASTM D 1557-91	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).
3.	ASTM D 2922-96	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4.	ASTM D 3017-96	Standard Test Method for Water content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
5.	ASTM D 4318-95a	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.05 SUBMITTALS

A. Submit copies of materials certificates and test results for materials in accordance with type of tests, frequencies and remarks as outlined in the sampling and testing schedule.

1.06 TESTING AND INSPECTION

A. General: The Contractor shall employ the services of a registered, licensed Geotechnical Engineer to observe all controlled earthwork soil testing. The testing laboratory shall provide continuous on-site observation by experienced personnel during construction of fill material. The Contractor shall notify the testing laboratory at least two working days in advance of any field operations of controlled earthwork, or of any resumption of operations after stoppages.

B. Report of Field Density Tests

1. The Geotechnical Engineer shall submit, daily, the results of field density tests required by these specifications.

C. Costs of Tests and Inspection

1. The cost of testing, inspecting and engineering, as specified in this section of the specifications, shall be borne by the Contractor.

D. Lines and Grades: Alignment and grade of all elements shall be made on true tangents and curves. Grades shall conform to the elevations indicated on Drawings, with minor adjustments, to provide a smooth approach at building lines, at connections to existing paving and to provide proper drainage. Correct irregularities at no cost to the Owner.

1.07 WEATHER LIMITATIONS

A. Controlled fill shall not be constructed when the atmospheric temperature is below 35 degrees F. When the temperature falls below 35 degrees, it shall be the responsibility of the Contractor to protect all areas of completed work against any detrimental effects of ground freezing by methods approved by the testing laboratory. Any areas that are damaged by freezing shall be reconditioned, reshaped, and compacted by the Contractor in conformance with the requirements of this specification without additional cost to the Owner.

PART 2 PRODUCTS

2.01 NON - STRUCTURAL FILL MATERIAL

A. The material shall be clean, free of roots, organic matter, trash, debris, lumps or stones larger than 6 inches.

2.02 STRUCTURAL FILL MATERIAL

A. Material shall consist of soils that conform to the following physical characteristics:

Sieve Size Sq. Openings	Percent Passing By Weight

6 inch	100
4 inch	85 – 100
¾ inch	70 - 100
No. 4	50 - 100
No. 200	40 (max)

B. Maximum expansive potential (%)……1.5
C. Maximum soluble sulfates (%)……..0.10

PART 3 EXECUTION

3.01 PREPARATION

A. Clearing and Grubbing: Prior to placing structural fill all borrow areas and areas to receive structural fill shall be stripped of vegetation and deleterious materials. Strippings shall be hauled offsite or stockpiled for subsequent use in landscaped areas or non-structural fill areas as designated by the Owner or his representative and approved by the Geotechnical Engineer.

3.02 CONSTRUCTION AREA TREATMENT

A. Site Preparation - Fill Areas: Prior to placing structural fill the areas to be filled shall be scarified to a depth of eight inches and moisture conditioned as described below. The area to be filled shall then be compacted to a minimum of 95 percent of maximum density as determined in accordance with ASTM D 1557. Any soft or "spongy" areas shall be removed as directed by the Geotechnical Engineer and replaced with structural fill as described herein.

B. Site Preparation - Cut Areas: Following excavation to rough grade all building and pavement areas shall be scarified to a depth of eight inches and moisture conditioned as described below. All building and paved areas shall be compacted to a minimum of 95 percent of maximum density as determined by ASTM D 1557.

3.03 EQUIPMENT AND METHODS

A. In areas not accessible to heavy equipment, distribute by and compact with hand operated vibratory compactors.

3.04 BORROW

A. The Contractor shall provide sufficient material for fill to the lines, elevations and cross sections as shown on the contract drawings from borrow areas.

B. The Contractor shall obtain from the Owners of said borrow areas the right to excavate material, shall pay all royalties and other charges involved, and shall pay all expenses in developing the source including the cost of right-of-way required for hauling the material.

3.05 COMPACTION

A. Fill shall be spread in layers not exceeding 8 inches, watered as necessary, and compacted. Moisture content at time of compaction shall be 3 percent below optimum moisture or higher. A density of not less than 95 percent of maximum dry density within the building pads and paved areas shall be obtained. Fill areas outside the building pads and paved areas shall be compacted to 95 percent of maximum dry density.

B. Optimum moisture content and maximum dry density for each soil type used shall be determined in accordance with ASTM D 1557.

C. Compaction of the fill shall be by mechanical means only. Where vibratory compaction equipment is used, it shall be the Contractor's responsibility to ensure that the vibrations do not damage nearby buildings or other adjacent property. Where vibratory compaction is not possible, pneumatic rolling equipment shall be used.

MATERIAL	MINIMUM PERCENT COMPACTION
Structural & granular fill in construction area	95
Subgrade below structural fill	95
Structural fill under exterior walls	95
Subgrade under asphalt & sidewalks	95
Miscellaneous backfill	90

3.06 MOISTURE CONTROL

A. The material, while being compacted, shall be within the moisture range of 3% below to 3% above optimum, well distributed throughout the layer.

3.07 DENSITY REQUIREMENTS

A. Density of undisturbed soils, in-place fill and backfill shall be determined in accordance with the procedures of ASTM D 1556 or ASTM D 2922 and D 3017. If tests indicate that the density of in-place soil is less than required, the material shall be scarified, moistened or dried as necessary to obtain proper moisture content and recompacted as necessary to achieve the proper densities. Sufficient density tests shall be made and reports submitted by the Testing Laboratory indicating all cut and fill areas were compacted and graded in accordance with the requirements.

3.08 SLOPE PROTECTION & DRAINAGE

A. Berming and grading shall be done as may be necessary to prevent surface water from flowing into and out of the construction area. Any water accumulating therein shall be removed by pumping or by other methods.

3.09 SOIL EROSION PROTECTION

A. The Contractor shall ensure that no soil erodes or blows from the site into public right-of-way or onto private property.

B. The Contractor shall promptly clean up any material which erodes or blows into the public right-of-way or onto private property.

3.10 PRESERVATION OF PROPERTY

A. Provide temporary fences, barricades, coverings, or other protections to preserve existing items indicated to remain and to prevent injury or damage to persons or property. Apply protections to adjacent properties as required.

B. Restore damaged work to condition existing prior to start of work, unless otherwise directed.

3.11 EXISTING UTILITIES

A. The Contractor shall verify the location of any utility lines, pipelines, or underground utility lines in or near the area of the work in advance of and during Earthwork. The Contractor is fully responsible for any and all damage caused by failure to locate, identify and preserve any and all existing utilities, pipelines and underground utility lines. Repair damaged utilities to the satisfaction of the utility owner at no expense to the Owner.

B. Should uncharted or incorrectly charted piping or other utilities be encountered during grading, consult the Architect immediately for directions as to procedures.

C. Cooperate with the Owner and public or private utility companies in keeping service and facilities in operation.

3.12 WASTE

A. Dispose of all waste off Owner's property.

B. Burning of waste will not be permitted.

3.13 AIR POLLUTION

A. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt air pollution. Comply with governing regulations pertaining to environmental protection.

SAMPLING AND TESTING SCHEDULE
FOR EARTHWORK

FIELD QUALITY CONTROL

MATERIAL	TEST FOR	FREQUENCY	REMARKS
NATURAL GROUND	Compaction in accordance with ASTM D 1556 or ASTM D 2922 and D 3017	1 per 500 square yards of surface	Conduct a minimum of 2 tests on each section.
EMBANKMENT AND/OR SUBGRADE	Soil Conditions Moisture-Density in Accordance with ASTM D 1557	Test 1 per soil Classification	
	Compaction control in accordance with ASTM D 1556 or ASTM D 3017	1 per each lift every 300 square yards of surface	1) Immediately after placing 2) Conduct a minimum of 2 tests per section
		1 per each lift for each 100 cubic yards of fill	

END OF SECTION 312000

SECTION 321123

AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate base course.

1.2 RELATED SECTIONS

A. Section 312200 - Earthwork: Preparation of site for base course.

B. Section 321216 - Asphaltic Concrete Paving

C. Section 312520 - Cast-in-Place Concrete

1.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM).

1.	ASTM D 1556-90	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone.
2.	ASTM D 1557-91	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
3.	ASTM D 2922-96	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4.	ASTM D 3017-96	Standard Test Method for Water Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth)

B. New Mexico State Highway and Transportation Department (NMSHTD) - Standard Specifications for Highway and Bridge Construction (Standard Specification).

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregate Base Course shall conform to Section 303 Type II B of the NMSHTD Standard Specification.

2.2 GRADATION

A. Aggregate Base Course shall have the following gradation limits:

Sieve Size	% passing

1.0 inch	100
¾ inch	80 – 100
No. 4	30 – 60
No. 10	20 – 45
No. 200	3.0 – 10.0

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping and re-compacting.

B. Do not place base course on soft, muddy, or frozen surfaces.

3.3 AGGREGATE BASE COURSE PLACEMENT

A. Spread base course over prepared substrate to a total compacted thickness indicated on the Drawings.

B. Level and contour surfaces to elevations and gradients indicated.

C. Add water to assist compaction. If excess water is apparent, remove base course and aerate to reduce moisture content.

D. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

A. Flatness: Maximum variation measured with 10 foot straight edge 1/2 inch.

B. Scheduled Compacted Thickness: Within 1/2".

C. Variation From Design Elevation: Within 1/2".

3.5 TESTING AND INSPECTION

A. General: The Owner shall employ the services of a registered, licensed geotechnical engineer to observe all controlled earthwork soil testing. The testing laboratory shall provide continuous on-site observation by experienced personnel during construction of fill material. The Contractor shall notify the testing laboratory at least two working days in advance of any field operations of controlled earthwork, or of any resumption of operations after stoppages.

B. Report of Field Density Tests

1. The geotechnical engineer shall submit, daily, the results of field density tests required by these specifications.

C. Costs of Tests and Inspection

1. The cost of testing, inspecting and engineering, as specified in this section of the specifications, shall be borne by the Owner.

D. Compaction required is 95% of laboratory maximum density, not less than one test per 300 square yards.

END OF SECTION