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For Construction
E&C Engineers & Consultants, Inc.
TX Firm Registration No: F-003068
Date: 07-01-2019
Engineer of Record: Heather Camden, PE
State: of Texas License No: 86883

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by Heather
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E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068
2013 Uniform General Conditions
for
University of Texas System Building Construction Contracts

For use on all UT System and Institutional Construction Projects executed on or after August 23, 2013

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Article 1. Definitions

Unless the context clearly requires another meaning, the following terms have the meaning assigned herein.

1.1 Application for Payment means Contractor’s monthly partial invoice for payment that includes any portion of the Work that has been completed for which an invoice has not been submitted and performed in accordance with the requirements of the Contract Documents. The Application for Payment accurately reflects the progress of the Work, is itemized based on the Schedule of Values, bears the notarized signature of Contractor, and shall not include subcontracted items for which Contractor does not intend to pay.

1.2 Application for Final Payment means Contractor’s final invoice for payment that includes any portion of the Work that has been completed for which an invoice has not been submitted, amounts owing to adjustments to the final Contract Sum resulting from approved change orders, and release of remaining Contractor’s retainage.

1.3 Architect/Engineer (A/E) means a person registered as an architect pursuant to Tex. Occ. Code Ann., Chapter 1051, as a landscape architect pursuant to Tex. Occ. Code Ann., Chapter 1052, a person licensed as a professional engineer pursuant Tex. Occ. Code Ann., Chapter 1001, and/or a firm employed by Owner or Design-Build Contractor to provide professional architectural or engineering services and to exercise overall responsibility for the design of a Project or a significant portion thereof, and to perform the contract administration responsibilities set forth in the Contract.

1.4 Baseline Schedule means the initial time schedule prepared by Contractor for Owner’s information and acceptance that conveys Contractor’s and Subcontractors’ activities (including coordination and review activities required in the Contract Documents to be performed by A/E and ODR), durations, and sequence of work related to the entire Project to the extent required by the Contract Documents. The schedule clearly demonstrates the critical path of activities, durations and necessary predecessor conditions that drive the end date of the schedule. The Baseline Schedule shall not exceed the time limit current under the Contract Documents.

1.5 Certificate of Final Completion means the certificate issued by A/E that documents, to the best of A/E’s knowledge and understanding, Contractor’s completion of all Contractor’s Punchlist items and pre-final Punchlist items, final cleanup and Contractor’s provision of Record Documents, operations and maintenance manuals, and all other Close-Out documents required by the Contract Documents.

1.6 Change Order means a written modification of the Contract between Owner and Contractor, signed by Owner, Contractor and A/E.

1.7 Close-out Documents mean the product brochures, submittals, product/equipment maintenance and operations instructions, manuals, and other documents/warranties, record documents, affidavit of payment, release of lien and claim, and as may be further defined, identified, and required by the Contract Documents.

1.8 Contract means the entire agreement between Owner and Contractor, including all of the Contract Documents.

1.9 Contract Date is the date when the agreement between Owner and Contractor becomes effective.

1.10 Contract Documents mean those documents identified as a component of the agreement (Contract) between Owner and Contractor. These may include, but are not limited to, Drawings; Specifications; these General Conditions and Owner’s Special Conditions; and all pre-bid and/or pre-proposal addenda.

1.11 Contract Sum means the total compensation payable to Contractor for completion of the Work in accordance with the terms of the Contract.

1.12 Contract Time means the period between the start date identified in the Notice to Proceed with construction and the Substantial Completion date identified in the Notice to Proceed or as subsequently amended by a Change Order.
1.13 **Contractor** means the individual, corporation, limited liability company, partnership, firm, or other entity contracted to perform the Work, regardless of the type of construction contract used, so that the term as used herein includes a Construction Manager-at-Risk or a Design-Build firm as well as a general or prime Contractor. The Contract Documents refer to Contractor as if singular in number.

1.14 **Construction Documents** mean the Drawings, Specifications, and other documents issued to build the Project. Construction Documents become part of the Contract Documents when listed in the Contract or any Change Order.

1.15 **Construction Manager-at-Risk**, in accordance with Tex. Educ. Code § 51.782, means a sole proprietorship, partnership, corporation, or other legal entity that assumes the risk for construction, rehabilitation, alteration, or repair of a facility at the contracted price as a general contractor and provides consultation to Owner regarding construction during and after the design of the facility.

1.16 **Date of Commencement** means the date designated in the Notice to Proceed for Contractor to commence the Work.

1.17 **Day** means a calendar day unless otherwise specifically stipulated.

1.18 **Design-Build** means a project delivery method in which the detailed design and subsequent construction is provided through a single contract with a Design-Build firm; a team, partnership, or legal entity that includes design professionals and a builder. The Design-Build Project delivery shall be implemented in accordance with Tex. Educ. Code § 51.780.

1.19 **Drawings** mean that product of A/E which graphically depicts the Work.

1.20 **Final Completion** means the date determined and certified by A/E and Owner on which the Work is fully and satisfactorily complete in accordance with the Contract.

1.21 **Final Payment** means the last and final monetary compensation made to Contractor for any portion of the Work that has been completed and accepted for which payment has not been made, amounts owing to adjustments to the final Contract Sum resulting from approved change orders, and release of Contractor’s retainage.

1.22 **Historically Underutilized Business (HUB)** pursuant to Tex. Gov’t Code, Chapter 2161, means a business that is at least 51% owned by an Asian Pacific American, a Black American, a Hispanic American, a Native American and/or an American Woman; is an entity with its principal place of business in Texas; and has an owner residing in Texas with proportionate interest that actively participates in the control, operations, and management of the entity’s affairs.

1.23 **Notice to Proceed** means written document informing Contractor of the dates beginning Work and the dates anticipated for Substantial Completion.

1.24 **Open Item List** means a list of work activities, Punchlist items, changes or other issues that are not expected by Owner and Contractor to be complete prior to Substantial Completion.

1.25 **Owner** means the State of Texas, and any agency of the State of Texas, acting through the responsible entity of the State of Texas identified in the Contract as Owner.

1.26 **Owner’s Designated Representative (ODR)** means the individual assigned by Owner to act on its behalf and to undertake certain activities as specifically outlined in the Contract. ODR is the only party authorized to direct changes to the scope, cost, or time of the Contract.

1.27 **Owner’s Special Conditions** mean the documents containing terms and conditions which may be unique to the Project. Owner’s Special Conditions are a part of the Contract Documents and have
precedence over the Uniform General Conditions

1.28 Project means all activities necessary for realization Owner’s desired building or other structure including all ancillary and related work. This includes design, contract award(s), execution of the Work itself, work by Owner’s forces and/or other contractors and fulfillment of all Contract and warranty obligations.

1.29 Progress Assessment Report (PAR) means the monthly compliance report to Owner verifying compliance with the HUB subcontracting plan (HSP).

1.30 Proposed Change Order (PCO) means a document that informs Contractor of a proposed change in the Work and appropriately describes or otherwise documents such change including Contractor’s response of pricing for the proposed change.

1.31 Punchlist means a list of items of Work to be completed or corrected by Contractor before Final Completion. Punchlists indicate items to be finished, remaining Work to be performed, or Work that does not meet quality or quantity requirements as required in the Contract Documents.

1.32 Record Documents mean the drawing set, Specifications, and other materials maintained by Contractor that documents all addenda, Architect’s Supplemental Instructions, Change Orders and postings and markings that record the as-constructed conditions of the Work and all changes made during construction.

1.33 Request for Information (RFI) means a written request by Contractor directed to A/E or ODR for a clarification of the information provided in the Contract Documents or for direction concerning information necessary to perform the Work that may be omitted from the Contract Documents.

1.34 Samples mean representative physical examples of materials, equipment, or workmanship used to confirm compliance with requirements and/or to establish standards for use in execution of the Work.

1.35 Schedule of Values means the detailed breakdown of the cost of the materials, labor, and equipment necessary to accomplish the Work as described in the Contract Documents, submitted by Contractor for approval by Owner and A/E.

1.36 Shop Drawings mean the drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data prepared by Contractor or its agents which detail a portion of the Work.

1.37 Site means the geographical area of the location of the Work.

1.38 Specifications mean the written product of A/E that establishes the quality and/or performance of products utilized in the Work and processes to be used, including testing and verification for producing the Work.

1.39 Subcontractor means a business entity that enters into an agreement with Contractor to perform part of the Work or to provide services, materials, or equipment for use in the Work.

1.40 Submittal Register means a list provided by Contractor of all items to be furnished for review and approval by A/E and Owner and as identified in the Contract Documents including anticipated sequence and submittal dates.

1.41 Substantial Completion means the date determined and certified by Contractor, A/E, and Owner when the Work, or a designated portion thereof, is sufficiently complete, in accordance with the Contract, so as to be operational and fit for the use intended.

1.42 Unit Price Work means the Work, or a portion of the Work, paid for based on incremental units of measurement.
1.43 **Unilateral Change Order (ULCO)** means a Change Order issued by Owner without the complete agreement of Contractor, as to cost and/or time.

1.44 **Work** means the administration, procurement, materials, equipment, construction and all services necessary for Contractor, and/or its agents, to fulfill Contractor’s obligations under the Contract.

1.45 **Work Progress Schedule** means the continually updated time schedule prepared and monitored by Contractor that accurately indicates all necessary appropriate revisions as required by the conditions of the Work and the Project while maintaining a concise comparison to the Baseline Schedule.

**Article 2. Wage Rates and Other Laws Governing Construction**

2.1 **Environmental Regulations.** Contractor shall conduct activities in compliance with applicable laws and regulations and other requirements of the Contract relating to the environment and its protection at all times. Unless otherwise specifically determined, Owner is responsible for obtaining and maintaining permits related to stormwater run-off. Contractor shall conduct operations consistent with stormwater run-off permit conditions. Contractor is responsible for all items it brings to the Site, including hazardous materials, and all such items brought to the Site by its Subcontractors and suppliers, or by other entities subject to direction of Contractor. Contractor shall not incorporate hazardous materials into the Work without prior approval of Owner, and shall provide an affidavit attesting to such in association with request for Substantial Completion inspection.

2.2 **Wage Rates.** Contractor shall not pay less than the wage scale of the various classes of labor as shown on the prevailing wage schedule provided by Owner in the bid or proposal specifications. The specified wage rates are minimum rates only. Owner is not bound to pay any claims for additional compensation made by any Contractor because the Contractor pays wages in excess of the applicable minimum rate contained in the Contract. The prevailing wage schedule is not a representation that qualified labor adequate to perform the Work is available locally at the prevailing wage rates.

2.2.1 **Notification to Workers.** Contractor shall post the prevailing wage schedule in a place conspicuous to all workers on the Project Site and shall notify each worker, in writing, of the following as they commence work on the Contract: the worker’s job classification, the established minimum wage rate requirement for that classification, as well as the worker’s actual wage. The notice must be delivered to and signed in acknowledgement of receipt by the worker and must list both the wages and fringe benefits to be paid or furnished for each classification in which the worker is assigned duties. When requested by Owner, Contractor shall furnish evidence of compliance with the Texas Prevailing Wage Law and the addresses of all workers.

2.2.1.1 Contractor shall submit a copy of each worker’s wage-rate notification to ODR with the application for progress payment for the period during which the worker was engaged in activities on behalf of the Project.

2.2.1.2 The prevailing wage schedule is determined by Owner in compliance with Tex. Gov’t Code, Chapter 2258. Should Contractor at any time become aware that a particular skill or trade not reflected on Owner’s prevailing wage schedule will be or is being employed in the Work, whether by Contractor or by Subcontractor, Contractor shall promptly inform ODR of the proposed wage to be paid for the skill along with a justification for same and ODR shall promptly concur with or reject the proposed wage and classification. Contractor is responsible for determining the most appropriate wage for a particular skill in relation to similar skills or trades identified on the prevailing wage schedule. In no case, shall any worker be paid less than the wage indicated for laborers.

2.2.2 **Penalty for Violation.** Contractor, and any Subcontractor, will pay to the State a penalty of
sixty dollars ($60) for each worker employed for each day, or portion thereof, that the worker is paid less than the wage rates stipulated in the prevailing wage schedule.

2.2.3 Complaints of Violations.

2.2.3.1 Owner’s Determination of Good Cause. Upon receipt of information concerning a violation, Owner will conduct an investigation in accordance with Tex. Gov’t Code, Chapter 2258 and make an initial determination as to whether good cause exists that a violation occurred. Upon making a good cause finding, Owner will retain the full amounts claimed by the claimant or claimants as the difference between wages paid and wages due under the prevailing wage schedule and any supplements thereto, together with the applicable penalties, such amounts being subtracted from successive progress payments pending a final decision on the violation.

2.2.3.2 No Extension of Time. If Owner’s determination proves valid that good cause existed to believe a violation had occurred, Contractor is not entitled to an extension of time for any delay arising directly or indirectly from the arbitration procedures.

2.3 Venue for Suits. The venue for any suit arising from the Contract will be in a court of competent jurisdiction in Travis County, Texas, or as may otherwise be designated in the Owner’s Special Conditions.

2.4 Licensing of Trades. Contractor shall comply with all applicable provisions of State law related to license requirements for skilled tradesmen, contractors, suppliers and or laborers, as necessary to accomplish the Work. In the event Contractor, or one of its Subcontractors, loses its license during the term of performance of the Contract, Contractor shall promptly hire or contract with a licensed provider of the service at no additional cost to Owner.

2.5 Royalties, Patents, and Copyrights. Contractor shall pay all royalties and license fees, defend suits or claims for infringement of copyrights and patent rights, and shall hold Owner harmless from loss on account thereof, but shall not be responsible for such defense or loss when a particular design, process or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications or other documents prepared by Owner or A/E. However, if Contractor has reason to believe that the required design, process, or product is an infringement of a copyright or a patent, Contractor shall be responsible for such loss unless such information is promptly furnished to A/E.

2.6 State Sales and Use Taxes. Owner qualifies for exemption from certain State and local sales and use taxes pursuant to the provisions of Tex. Tax Code, Chapter 151. Upon request from Contractor, Owner shall furnish evidence of tax exempt status. Contractor may claim exemption from payment of certain applicable State taxes by complying with such procedures as prescribed by the State Comptroller of Public Accounts. Owner acknowledges not all items qualify for exemption. Owner is not obligated to reimburse Contractor for taxes paid on items that qualify for tax exemption.

Article 3. General Responsibilities of Owner and Contractor

3.1 Owner’s General Responsibilities. Owner is the entity identified as such in the Contract and referred to throughout the Contract Documents as if singular in number.

3.1.1 Preconstruction Conference. Prior to, or concurrent with, the issuance of Notice to Proceed with construction, a conference will be convened for attendance by Owner, Contractor, A/E and appropriate Subcontractors. The purpose of the conference is to establish a working understanding among the parties as to the Work, the operational conditions at the Project Site, and general administration of the Project. Topics include communications, schedules,
procedures for handling Shop Drawings and other submittals, processing Applications for Payment, maintaining required records and all other matters of importance to the administration of the Project and effective communications between the Project team members.

3.1.2 Owner’s Designated Representative. Prior to the start of construction, Owner will identify Owner’s Designated Representative (ODR), who has the express authority to act and bind Owner to the extent and for the purposes described in the various Articles of the Contract, including responsibilities for general administration of the Contract.

3.1.2.1 Unless otherwise specifically defined elsewhere in the Contract Documents, ODR is the single point of contact between Owner and Contractor. Notice to ODR, unless otherwise noted, constitutes notice to Owner under the Contract.

3.1.2.2 All directives on behalf of Owner will be conveyed to Contractor and A/E by ODR in writing.

3.1.2.3 Owner will furnish or cause to be furnished, free of charge, the number of complete sets of the Drawings, Specifications, and addenda as provided in the Agreement or Owner’s Special Conditions.

3.1.3 Owner Supplied Materials and Information.

3.1.3.1 Owner will furnish to Contractor those surveys describing the physical characteristics, legal description, limitations of the Site, Site utility locations, and other information used in the preparation of the Contract Documents.

3.1.3.2 Owner will provide information, equipment, or services under Owner’s control to Contractor with reasonable promptness.

3.1.4 Availability of Lands. Owner will furnish, as indicated in the Contract, all required rights to use the lands upon which the Work occurs. This includes rights-of-way and easements for access and such other lands that are designated for use by Contractor. Contractor shall comply with all Owner identified encumbrances or restrictions specifically related to use of lands so furnished. Owner will obtain and pay for easements for permanent structures or permanent changes in existing facilities, unless otherwise required in the Contract Documents.

3.1.5 Limitation on Owner’s Duties.

3.1.5.1 Owner will not supervise, direct, control or have authority over or be responsible for Contractor’s means, methods, technologies, sequences or procedures of construction or the safety precautions and programs incident thereto. Owner is not responsible for any failure of Contractor to comply with laws and regulations applicable to the Work. Owner is not responsible for the failure of Contractor to perform or furnish the Work in accordance with the Contract Documents. Except as provided in Section 2.5, Owner is not responsible for the acts or omissions of Contractor, or any of its Subcontractors, suppliers or of any other person or organization performing or furnishing any of the Work on behalf of Contractor.

3.1.5.2 Owner will not take any action in contravention of a design decision made by A/E in preparation of the Contract Documents, when such actions are in conflict with statutes under which A/E is licensed for the protection of the public health and safety.

3.2 Role of Architect/Engineer. Unless specified otherwise in the Contract between Owner and Contractor, A/E shall provide general administration services for Owner during the construction phase.
of the project. Written correspondence, requests for information, and Shop Drawings/submittals shall be directed to A/E for action. A/E has the authority to act on behalf of Owner to the extent provided in the Contract Documents, unless otherwise modified by written instrument, which will be furnished to Contractor by ODR, upon request.

3.2.1 Site Visits.

3.2.1.1 A/E will make visits to the Site at intervals as provided in the A/E’s Contract with Owner, to observe the progress and the quality of the various aspects of Contractor’s executed Work and report findings to Owner.

3.2.1.2 A/E has the authority to interpret Contract Documents and inspect the Work for compliance and conformance with the Contract. Except as referenced in Paragraph 3.1.5.2, Owner retains the sole authority to accept or reject Work and issue direction for correction, removal, or replacement of Work.

3.2.2 Clarifications and Interpretations. It may be determined that clarifications or interpretations of the Contract Documents are necessary. Upon direction by ODR, such clarifications or interpretations will be provided by A/E consistent with the intent of the Contract Documents. A/E will issue these clarifications with reasonable promptness to Contractor as A/E’s supplemental instruction (“ASI”) or similar instrument. If Contractor believes that such clarification or interpretation justifies an adjustment in the Contract Sum or the Contract Time, Contractor shall so notify Owner in accordance with the provisions of Article 11.

3.2.3 Limitations on Architect/Engineer Authority. A/E is not responsible for:

3.2.3.1 Contractor’s means, methods, techniques, sequences, procedures, safety, or programs incident to the Project, nor will A/E supervise, direct, control or have authority over the same;

3.2.3.2 The failure of Contractor to comply with laws and regulations applicable to the furnishing or performing the Work;

3.2.3.3 Contractor’s failure to perform or furnish the Work in accordance with the Contract Documents; or

3.2.3.4 Acts or omissions of Contractor, or of any other person or organization performing or furnishing any of the Work.

3.3 Contractor’s General Responsibilities. Contractor is solely responsible for implementing the Work in full compliance with all applicable laws and the Contract Documents and shall supervise and direct the Work using the best skill and attention to assure that each element of the Work conforms to the Contract requirements. Contractor is solely responsible for all construction means, methods, techniques, safety, sequences, coordination and procedures.

Contractor shall visit the Site before commencing the Work and become familiar with local conditions such as the location, accessibility and general character of the Site and/or building.

3.3.1 Project Administration. Contractor shall provide Project administration for all Subcontractors, vendors, suppliers, and others involved in implementing the Work and shall coordinate administration efforts with those of A/E and ODR in accordance with these general conditions, Division 1 of the Specifications and other provisions of the Contract, and as outlined in the pre-construction conference.

3.3.1.1 At the request of Owner and at no additional cost, Contractor shall furnish to the ODR one copy of the current edition of the RSMeans Facilities Construction
3.3.2 Contractor’s Management Personnel. Contractor shall employ a competent person or persons who will be present at the Project Site during the progress of the Work to supervise or oversee the work. The competent persons are subject to the approval of ODR. Contractor shall not change approved staff during the course of the project without the written approval of ODR unless the staff member leaves the employment of Contractor. Contractor shall provide additional quality control, safety and other staff as stated in the Contract Documents.

3.3.3 Labor. Contractor shall provide competent, suitably qualified personnel to survey, lay-out, and construct the Work as required by the Contract Documents and maintain good discipline and order at the Site at all times.

3.3.4 Services, Materials, and Equipment. Unless otherwise specified, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities, incidentals, and services necessary for the construction, performance, testing, start-up, inspection and completion of the Work.

3.3.5 Contractor General Responsibility. For Owner furnished equipment or material that will be in the care, custody, and control of Contractor, Contractor is responsible for damage or loss.

3.3.6 Non-Compliant Work. Should A/E and/or ODR identify Work as non-compliant with the Contract Documents, A/E and/or ODR shall communicate the finding to Contractor, and Contractor shall correct such Work at no additional cost to the Owner. The approval of Work or the failure to find non-compliant Work by either A/E or ODR does not relieve Contractor from the obligation to comply with all requirements of the Contract Documents.

3.3.7 Subcontractors. Contractor shall not employ any Subcontractor, supplier or other person or organization, whether initially or as a substitute, against whom Owner shall have reasonable objection. Owner will communicate such objections in writing within ten (10) days of receipt of Contractor’s intent to use such Subcontractor, supplier, or other person or organization. Contractor is not required to employ any Subcontractor, supplier or other person or organization to furnish any of the work to whom Contractor has reasonable objection. Contractor shall not substitute Subcontractors without the acceptance of Owner.

3.3.7.1 All Subcontracts and supply contracts shall be consistent with and bind the Subcontractors and suppliers to the terms and conditions of the Contract Documents including provisions of the Contract between Contractor and Owner.

3.3.7.2 Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with Contractor. Require all Subcontractors, suppliers and such other persons and organizations performing or furnishing any of the Work to communicate with Owner only through Contractor. Contractor shall furnish to Owner a copy, at Owner’s request, of each first-tier subcontract promptly after its execution. Contractor agrees that Owner has no obligation to review or approve the content of such contracts and that providing Owner such copies in no way relieves Contractor of any of the terms and conditions of the Contract, including, without limitation, any provisions of the Contract which require the Subcontractor to be bound to Contractor in the same manner in which Contractor is bound to Owner.

3.3.8 Continuing the Work. Contractor shall carry on the Work and adhere to the progress schedule during all disputes, disagreements, or alternative resolution processes with Owner. Contractor
shall not delay or postpone any Work because of pending unresolved disputes, disagreements
or alternative resolution processes, except as Owner and Contractor may agree in writing.

3.3.9 Cleaning. Contractor shall at all times, keep the Site and the Work clean and free from
accumulation of waste materials or rubbish caused by the construction activities under the
Contract. Contractor shall ensure that the entire Project is thoroughly cleaned prior to
requesting Substantial Completion inspection and, again, upon completion of the Project prior
to the final inspection.

3.3.10 Acts and Omissions of Contractor, its Subcontractors and Employees. Contractor shall be
responsible for acts and omissions of his employees and all its Subcontractors, their agents
and employees. Owner may, in writing, require Contractor to remove from the Project any of
Contractor’s or its Subcontractor’s employees whom ODR finds to be careless, incompetent,
unsafe, uncooperative, disruptive, or otherwise objectionable.

3.3.11 Ancillary Areas. Contractor shall operate and maintain operations and associated storage
areas at the site of the Work in accordance with the following:

3.3.11.1 All Contractor operations, including storage of materials and employee parking
upon the Site of Work, shall be confined to areas designated by Owner.

3.3.11.2 Contractor may erect, at its own expense, temporary buildings that will remain its
property. Contractor shall remove such buildings and associated utility service
lines upon completion of the Work, unless Contractor requests and Owner
provides written consent that it may abandon such buildings and utilities in place.

3.3.11.3 Contractor shall use only established roadways or construct and use such
temporary roadways as may be authorized by Owner. Contractor shall not allow
load limits of vehicles to exceed the limits prescribed by appropriate regulations or
law. Contractor shall provide protection to road surfaces, curbs, sidewalks, trees,
shrubbery, sprinkler systems, drainage structures and other like existing
improvements to prevent damage and repair any damage thereto at the expense of
Contractor.

3.3.11.4 Owner may restrict Contractor’s entry to the Site to specifically assigned entrances
and routes.

3.3.12 Separate Contracts. Owner reserves the right to award other contracts in connection with the
Project under the same or substantially similar contract terms, including those portions related
to insurance and waiver of subrogation. Owner reserves the right to perform operations
related to the Project with Owner’s own forces.

3.3.13 Under a system of separate contracts, the conditions described herein continue to apply except
as may be amended by change order.

3.3.14 Contractor shall cooperate with other contractors or forces employed on the Project by
Owner, including providing access to Site, integration of activities within Contractor’s Work
Progress Schedule and Project information as requested.

3.3.15 Owner shall be reimbursed by Contractor for costs incurred by Owner which are payable to a
separate contractor because of delays, improperly timed activities, or defective construction
by Contractor. Owner will equitably adjust the Contract by Change Order for costs incurred
by Contractor because of delays, improperly timed activities, damage to the Work or defective
construction by a separate contractor.

3.4 Indemnification of Owner.
3.4.1 Contractor covenants and agrees to FULLY INDEMNIFY and HOLD HARMLESS, Owner and the elected and appointed officials, employees, officers, directors, volunteers, and representatives of Owner, individually or collectively, from and against any and all costs, claims, liens, damages, losses, expenses, fees, fines, penalties, proceedings, actions, demands, causes of action, liability and suits of any kind and nature, including but not limited to, personal or bodily injury, death or property damage, made upon Owner directly or indirectly arising out of, resulting from or related to Contractor’s activities under this Contract, including any acts or omissions of Contractor, or any agent, officer, director, representative, employee, consultant or the Subcontractor of Contractor, and their respective officers, agents, employees, directors and representatives while in the exercise of performance of the rights or duties under this Contract. The indemnity provided for in this paragraph does not apply to any liability resulting from the negligence of the Owner, its officers or employees, separate contractors or assigned contractors, in instances where such negligence causes personal injury, death or property damage. IN THE EVENT CONTRACTOR AND OWNER ARE FOUND JOINTLY LIABLE BY A COURT OF COMPETENT JURISDICTION, LIABILITY WILL BE APPORTIONED COMPARATIVELY IN ACCORDANCE WITH THE LAWS OF THE STATE OF TEXAS, WITHOUT WAIVING ANY GOVERNMENTAL IMMUNITY AVAILABLE TO THE STATE UNDER TEXAS LAW AND WITHOUT WAIVING ANY DEFENSES OF THE PARTIES UNDER TEXAS LAW.

3.4.2 Contractor shall protect and indemnify the Owner from and against all claims, damages, judgments and losses arising from infringement or alleged infringement of any United States patent, or copyright that arise out of any of the work performed by the Contractor or the use by Contractor, or by Owner at the direction of Contractor, of any article or material. Upon becoming aware of a suit or threat of suit for patent or copyright infringement, Owner shall promptly notify Contractor and Contractor shall be given full opportunity to negotiate a settlement. Contractor does not warrant against infringement by reason of Owner's or Project Architect's design of articles or their use in combination with other materials or in the operation of any process. In the event of litigation, Owner agrees to cooperate reasonably with Contractor and parties shall be entitled, in connection with any such litigation, to be represented by counsel at their own expense.

3.4.3 The provisions of this indemnification are solely for the benefit of the parties hereto and not intended to create or grant any rights, contractual or otherwise, to any other person or entity.

3.4.4 Contractor shall promptly advise Owner in writing of any claim or demand against Owner or against Contractor which involves Owner and known to Contractor and related to or arising out of Contractor’s activities under this Contract.

3.4.5 These indemnity provisions shall survive the termination of this Agreement regardless of the reason for termination.

Article 4. Historically Underutilized Business (HUB) Subcontracting Plan

4.1 General Description. The purpose of the Historically Underutilized Business (HUB) program is to promote equal business opportunities for economically disadvantaged persons (as defined by Tex. Gov’t Code, Chapter 2161) to contract with the State of Texas in accordance with the goals specified in the State of Texas Disparity Study. The HUB program annual procurement utilization goals are defined in 34 T.A.C. § 20.13(b).

4.1.1 State agencies are required by statute to make a good faith effort to assist HUBs in participating in contract awards issued by the State. 34 T.A.C. § 20.13(b) outlines the State’s
policy to encourage the utilization of HUBs in State contracting opportunities through race, ethnic and gender neutral means.

4.1.2 A Contractor who contracts with the State in an amount of $100,000 or greater is required to make a good faith effort to award subcontracts to HUBs in accordance with 34 T.A.C. § 20.14(a)(2)(A) by submitting a HUB subcontracting plan within twenty-four (24) hours after the bid or response is due and complying with the HUB subcontracting plan after it is accepted by Owner and during the term of the Contract.

4.2 Compliance with Approved HUB Subcontracting Plan. Contractor, having been awarded this Contract in part by complying with the HUB program statute and rules, hereby covenants to continue to comply with the HUB program as follows:

4.2.1 Prior to adding or substituting a Subcontractor, promptly notify Owner in the event a change is required for any reason to the accepted HUB subcontracting plan.

4.2.2 Conduct the good-faith effort activities required and provide Owner with necessary documentation to justify approval of a change to the approved HUB subcontracting plan.

4.2.3 Cooperate in the execution of a Change Order or such other approval of the change in the HUB subcontracting plans as Contractor and Owner may agree to.

4.2.4 Maintain and make available to Owner upon request business records documenting compliance with the accepted HUB subcontracting plan.

4.2.5 Upon receipt of payment for performance of Work, submit to Owner a compliance report, in the format required by Owner that demonstrates Contractor’s performance of the HUB subcontracting plan.

4.2.5.1 Progress Assessment Report (PAR): monthly compliance reports to Owner (contracting agency), verifying their compliance with the HUB subcontracting plan, including the use/expenditures they have made to Subcontractors. (The PAR is available at http://www.window.state.tx.us/procurement/prog/hub/hub-forms/progressassessmenrpt.xls).

4.2.6 Promptly and accurately explain and provide supplemental information to Owner to assist in Owner’s investigation of Contractor’s good-faith effort to fulfill the HUB subcontracting plan and the requirements under 34 T.A.C. § 20.14(a)(1).

4.3 Failure to Demonstrate Good-Faith Effort. Upon a determination by Owner that Contractor has failed to demonstrate a good-faith effort to fulfill the HUB subcontracting plan or any Contract covenant detailed above, Owner may, in addition to all other remedies available to it, report the failure to perform to the Comptroller of Public Accounts, Texas Procurement and Support Services Division, Historically Underutilized Business Program and may bar Contractor from future contracting opportunities with Owner.

Article 5. Bonds and Insurance

5.1 Construction Bonds. Contractor is required to tender to Owner, prior to commencing the Work, performance and payment bonds, as required by Tex. Gov’t Code, Chapter 2253. On Construction Manager-at-Risk and Design-Build Projects the Owner shall require a security bond, as described in Subsection 5.1.2 below.

5.1.1 Bond Requirements. Each bond shall be executed by a corporate surety or sureties authorized to do business in the State of Texas and acceptable to Owner, on Owner’s form, and in compliance with the relevant provisions of the Texas Insurance Code. If any bond is for more
than ten (10) percent of the surety’s capital and surplus, Owner may require certification that the company has reinsured the excess portion with one or more reinsurers authorized to do business in the State. A reinsurer may not reinsure for more than ten (10) percent of its capital and surplus. If a surety upon a bond loses its authority to do business in the State, Contractor shall, within thirty (30) days after such loss, furnish a replacement bond at no added cost to Owner.

5.1.1.1 A Performance bond is required if the Contract Sum is in excess of $100,000. The performance bond is solely for the protection of Owner. The performance bond is to be for the Contract Sum to guarantee the faithful performance of the Work in accordance with the Contract Documents. The form of the bond shall be approved by the Office of the Attorney General of Texas. The performance bond shall be effective through Contractor’s warranty period.

5.1.1.2 A Payment bond is required if the Contract price is in excess of $25,000. The payment bond is to be for the Contract Sum and is payable to Owner solely for the protection and use of payment bond beneficiaries. The form of the bond shall be approved by the Office of the Attorney General of Texas.

5.1.2 Security Bond. The security bond provides protection to Owner if Contractor presents an acceptable guaranteed maximum price (“GMP”) to Owner but is unable to deliver the required payment and performance bonds within the time period stated below.

5.1.3 When Bonds Are Due

5.1.3.1 Security bonds are due before execution of a Construction Manager-at-Risk or Design-Build Contract.

5.1.3.2 Payment and performance bonds are due before execution of a contract on competitively bid or competitively sealed proposal projects or before execution of a GMP proposal on Construction Manager-at-Risk projects or Design-Build projects.

5.1.4 Power of Attorney. Each bond shall be accompanied by a valid power of attorney (issued by the surety company and attached, signed and sealed with the corporate embossed seal, to the bond) authorizing the attorney-in-fact who signs the bond to commit the company to the terms of the bond, and stating any limit in the amount for which the attorney can issue a single bond.

5.1.5 Bond Indemnification. The process of requiring and accepting bonds and making claims thereunder shall be conducted in compliance with Tex. Gov’t Code, Chapter 2253. IF FOR ANY REASON A STATUTORY PAYMENT OR PERFORMANCE BOND IS NOT HONORED BY THE SURETY, CONTRACTOR SHALL FULLY INDEMNIFY AND HOLD OWNER HARMLESS OF AND FROM ANY COSTS, LOSSES, OBLIGATIONS OR LIABILITIES IT INCURS AS A RESULT.

5.1.6 Furnishing Bond Information. Owner shall furnish certified copies of the payment bond and the related Contract to any qualified person seeking copies who complies with Tex. Gov’t Code § 2253.026.

5.1.7 Claims on Payment Bonds. Claims on payment bonds must be sent directly to Contractor and his surety in accordance with Tex. Gov’t Code § 2253.041. All payment bond claimants are cautioned that no lien exists on the funds unpaid to Contractor on such Contract, and that reliance on notices sent to Owner may result in loss of their rights against Contractor and/or his surety. Owner is not responsible in any manner to a claimant for collection of unpaid bills, and accepts no such responsibility because of any representation by any agent or
employee.

5.1.8 Payment Claims when Payment Bond not Required. The rights of Subcontractors regarding payment are governed by Tex. Prop. Code §§ 53.231 – 53.239 when the value of the Contract between Owner and Contractor is less than $25,000.00. These provisions set out the requirements for filing a valid lien on funds unpaid to Contractor as of the time of filing the claim, actions necessary to release the lien and satisfaction of such claim.

5.1.9 Sureties. A surety shall be listed on the US Department of the Treasury’s Listing of Approved Sureties maintained by the Bureau of Financial Management Service (FMS), www.fms.treas.gov/c570, stating companies holding Certificates of Authority as acceptable sureties on Federal bonds and acceptable reinsuring companies (FMS Circular 570).

5.2 Insurance Requirements. contractor shall carry insurance in the types and amounts indicated in this Article for the duration of the Contract. The required insurance shall include coverage for Owner’s property prior to construction, during construction and during the warranty period. The insurance shall be evidenced by delivery to Owner of certificates of insurance executed by the insurer or its authorized agent stating coverages, limits, expiration dates and compliance with all applicable required provisions. Upon request, Owner, and/or its agents, shall be entitled to receive without expense, copies of the policies and all endorsements. Contractor shall update all expired policies prior to submission for monthly payment. Failure to update policies shall be reason for withholding of payment until renewal is provided to Owner.

5.2.1 Contractor, consistent with its status as an independent contractor, shall provide and maintain all insurance coverage with the minimum amounts described below until the end of the warranty period unless otherwise stated in Owner’s Insurance Specifications Special Conditions. Failure to maintain insurance coverage, as required, is grounds for suspension of Work for cause pursuant to Article 14. The Contractor will be notified of the date on which the Builder’s Risk insurance policy may be terminated by any means deemed appropriate by Owner.

5.2.2 Coverage shall be written on an occurrence basis by companies authorized and admitted to do business in the State of Texas and rated A-, VII or better by A.M. Best Company or similar rating company or otherwise acceptable to Owner.

5.2.2.1 Insurance Coverage Required.

5.2.2.1.1 Workers’ Compensation. Insurance with limits as required by the Texas Workers’ Compensation Act and Employer’s Liability Insurance with limits of not less than:

$1,000,000 each accident;

$1,000,000 disease each employee; and

$1,000,000 disease policy limit.

Policies must include (a) Other States Endorsement to include TEXAS if business is domiciled outside the State of Texas, and (b) a waiver of all rights of subrogation in favor of Owner.

5.2.2.1.2 Commercial General Liability Insurance, including premises, operations, independent contractor’s liability, products and completed operations and contractual liability, covering, but not limited to, the liability assumed under the indemnification provisions of this Contract, fully insuring Contractor’s (or Subcontractor’s)
liability for bodily injury (including death) and property damage with a minimum limit of:

$1,000,000 per occurrence;

$2,000,000 general aggregate;

$2,000,000 products and completed operations aggregate; and

Coverage shall be on an “occurrence” basis.

The policy shall include coverage extended to apply to completed operations and explosion, collapse, and underground hazards. The policy shall include endorsement CG2503 Amendment of Aggregate Limits of Insurance (per Project) or its equivalent.

If the Work involves any activities within fifty (50) feet of any railroad, railroad protective insurance as may be required by the affected railroad, written for not less than the limits required by such railroad.

5.2.2.1.3 Asbestos Abatement Liability Insurance, including coverage for liability arising from the encapsulation, removal, handling, storage, transportation, and disposal of asbestos containing materials. *This requirement applies if the Work or the Project includes asbestos containing materials.

The combined single limit for bodily injury and property damage will be a minimum of $1,000,000 per occurrence.

*Specific requirement for claims-made form: Required period of coverage will be determined by the following formula: continuous coverage for life of the Contract, plus one (1) year (to provide coverage for the warranty period), and an extended discovery period for a minimum of five (5) years which shall begin at the end of the warranty period.

Employer’s liability limits for asbestos abatement will be:

$1,000,000 each accident;

$1,000,000 disease each employee; and

$1,000,000 disease policy limit.

If this Contract is for asbestos abatement only, the All-Risk Builder’s Risk or all-risk installation floater (5.2.2.1.5.e) is not required.

5.2.2.1.4 Business Automobile Liability Insurance, covering all owned, hired, and non-owned vehicles, with a minimum combined single limit for bodily injury (including death) and property damage of $1,000,000 per occurrence. No aggregate shall be permitted for this type of coverage.

Such insurance is to include coverage for loading and unloading
Contractor or any subcontractor responsible for transporting asbestos or other hazardous materials defined as asbestos shall provide pollution coverage for any vehicle hauling asbestos containing cargo. The policy must include a MCS 90 endorsement with a $5,000,000 limit and the CA 9948 Pollution Endorsement, or its equivalent.

5.2.2.1.5 All-Risk Builder’s Risk Insurance, if applicable (or all-risk installation floater for instances in which the project involves solely the installation of material and/or equipment). Coverage is determined by the Contract Sum, as detailed, below.

**BUILDERS RISK REQUIREMENT FOR PROJECTS WITH A CONTRACT SUM <$20 MILLION**

5.2.2.1.5.1 Contractor shall purchase and maintain in force builders risk insurance on the entire Work. Such insurance shall be written in the amount of the original contract, plus any subsequent change orders and plus the cost of materials supplied or installed by others, comprising Total Value for the entire Project at the site. The insurance shall apply on a replacement cost basis with no coinsurance provision. A sublimit may be applicable to flood coverage, but sublimit must be at least 20% of the Total Value of the Project. The limit for all other perils, including Named Windstorm, Wind, and Hail, must be equal to the Total Value for the entire Project at the site. (If Installation Floater, limit shall be equal to 100 percent of the contract cost.)

5.2.2.1.5.2 This insurance shall name as insureds the Owner, the Contractor, and all subcontractors and sub-subcontractors in the Work.

5.2.2.1.5.3 Builders risk insurance shall be on an “all risk” or equivalent policy form and shall include, without limitation, insurance against fire and extended coverage perils, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, boiler and machinery/mechanical breakdown, testing and startup, and terrorism.

5.2.2.1.5.4 This insurance shall cover the entire work at the site as required in 5.2.2.1.5.1, including, but not limited to, the following:

- Temporary works including but not limited to scaffolding, form work, fences, shoring, hoarding, falsework and temporary buildings
- Offsite Storage
- Portions of the work in transit
- Debris removal
- Extra Expense
- Expediting Expenses
- Demolition and Increased Cost of Construction
- Pollutant Clean-Up and Removal
- Trees, Shrubs, Plants, Lawns and Landscaping (if applicable)
- Errors & Omissions (applicable to purchase of Builders Risk policy only)

5.2.2.1.5.5 This insurance shall not contain an occupancy clause suspending or reducing coverage should the Owner occupy, or begin beneficial occupancy before the Owner has accepted final completion.

5.2.2.1.5.6 This insurance shall be specific as to coverage and shall be primary to any permanent insurance or self-insurance that may be maintained on the property by Owner.

5.2.2.1.5.7 This insurance shall include a waiver of subrogation in favor of Owner, the Contractor, and all subcontractors and sub-subcontractors in the work.
5.2.2.1.5.8 As applicable, Flood deductible shall not exceed $250,000 for Zone A, $100,000 for Zone B and $50,000 for all other Zones. For Tier 1 and Tier 2, Named Windstorm deductible shall not exceed 2% of the project values in place at the time of the loss.

5.2.2.1.5.9 Before the commencement of the work, Contractor shall provide to Owner an accurate certificate of insurance that provides specific evidence of all requirements outlined in Section 5.2.2.1.5. A copy of the policy itself shall be provided to Owner within 30 days after Notice to Proceed.

5.2.2.1.5.10 Refer to Owner’s Insurance Specifications Special Conditions for possible additional Builders Risk insurance requirements.

BUILDERS RISK REQUIREMENT FOR PROJECTS WITH A CONTRACT SUM ≥ $20 MILLION

5.2.2.1.5.1 Contractor shall purchase and maintain in force builders risk insurance on the entire Work. Such insurance shall be written in the amount of the original contract, plus any subsequent change orders and plus the cost of materials supplied or installed by others, comprising Total Value for the entire Project at the site. The insurance shall apply on a replacement cost basis with no coinsurance provision and shall include a margin clause of plus/minus 10% on project value. A sublimit may be applicable to flood coverage, but sublimit must be at least 20% of the Total Value of the Project. A sublimit of $50 million or the Total Value of the Project, whichever is less, is acceptable for Earthquake. The limit for all other perils, including Named Windstorm, Wind, and Hail, must be equal to the Total Value for the entire Project at the site. (If Installation Floater, limit shall be equal to 100 percent of the contract cost.)

5.2.2.1.5.2 This insurance shall name as insureds the Owner, the Contractor, and all subcontractors and sub-subcontractors in the Work.

5.2.2.1.5.3 Builders risk insurance shall be on an “all risk” or equivalent policy form and shall include, without limitation, insurance against fire and extended coverage perils, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, boiler and machinery/mechanical breakdown, testing and startup, and terrorism.

5.2.2.1.5.4 This insurance shall cover the entire work at the site as required in 5.2.2.1.5.1, including, but not limited to, the following:

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Minimum Limit Required</th>
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<tbody>
<tr>
<td>Temporary works including but not limited to scaffolding, form work,</td>
<td>$1 million</td>
</tr>
<tr>
<td>shoring, hoarding, falsework and temporary buildings</td>
<td></td>
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<tr>
<td>Offsite Storage</td>
<td>Sufficient to cover the anticipated maximum values stored</td>
</tr>
<tr>
<td>Portions of the work in Transit</td>
<td>anticipated maximum values in transit</td>
</tr>
<tr>
<td>Debris Removal</td>
<td>25% of Physical damage amount subject to maximum of $5</td>
</tr>
<tr>
<td></td>
<td>million or 25% of Total Value of Project whichever is higher</td>
</tr>
<tr>
<td>Expediting Expenses</td>
<td>$1 million</td>
</tr>
<tr>
<td>Extra Expense</td>
<td>$5 million</td>
</tr>
<tr>
<td>Demolition and Increased Cost of Construction</td>
<td>$2 million or 10% of Total Value of Project whichever is</td>
</tr>
<tr>
<td></td>
<td>higher</td>
</tr>
<tr>
<td>Pollutant Clean-Up and Removal</td>
<td>$250,000</td>
</tr>
<tr>
<td>Trees, Shrubs, Plants, Lawns and Landscaping (if applicable)</td>
<td>$2,500 per item subject to a maximum of $1 million</td>
</tr>
<tr>
<td>Errors &amp; Omissions (applicable to purchase of Builders Risk policy only)</td>
<td>$2.5 million</td>
</tr>
</tbody>
</table>
5.2.2.1.5.5 This insurance shall not contain an occupancy clause suspending or reducing coverage should the Owner occupy, or begin beneficial occupancy before the Owner has accepted final completion.

5.2.2.1.5.6 This insurance shall be specific as to coverage and shall be primary to any permanent insurance or self-insurance that may be maintained on the property by Owner.

5.2.2.1.5.7 This insurance shall include a waiver of subrogation in favor of Owner, the Contractor, and all subcontractors and sub-subcontractors in the work.

5.2.2.1.5.8 As applicable, Flood deductible shall not exceed $250,000 for Zone A, $100,000 for Zone B and $50,000 for all other Zones. For Tier 1 and Tier 2, Named Windstorm deductible shall not exceed 2% of the project values in place at the time of the loss.

5.2.2.1.5.9 Before the commencement of the work, Contractor shall provide to Owner an accurate certificate of insurance that provides specific evidence of all requirements outlined in Section 5.2.2.1.5. A copy of the policy itself shall be provided to Owner within 30 days after Notice to Proceed.

5.2.2.1.5.10 Refer to Owner’s Insurance Specifications Special Conditions for possible additional Builders Risk insurance requirements.

5.2.2.1.6 “Umbrella” Liability Insurance. On Projects that are not insured under the Owner’s Rolling Revolving Owner Controlled Insurance Program (ROCIP) or any project requiring demolition services, Contractor shall obtain, pay for and maintain umbrella liability insurance during the Contract term, insuring Contractor (or Subcontractor) that provides coverage at least as broad as and applies in excess and follows form of the primary liability coverages required above. The policy shall provide “drop down” coverage where underlying primary insurance coverage limits are insufficient or exhausted.

5.2.2.1.7 “Umbrella” Liability Insurance coverage shall be in the following amounts:

- If Contract sum is $1,000,000 or less: No Umbrella Required
- If Contract Sum is greater than $1,000,000 up to $3,000,000: $1,000,000 each occurrence and $2,000,000 annual aggregate
- If Contract Sum is greater than $3,000,000 up to $5,000,000: $5,000,000 each occurrence and $5,000,000 annual aggregate
- If Contract Sum is greater than $5,000,000: $10,000,000 each occurrence and $10,000,000 annual aggregate

5.2.3 All Policies must include the following clauses, as applicable:

5.2.3.1 Contractor must provide to Owner immediate notice of cancellation, material change, or non-renewal to any insurance coverages required herein above. This requirement may be satisfied by the Contractor providing a copy of the notice received by the insurer to Owner within two business days of date of receipt or by Endorsement of the policies that require Insurer to provide notice to Owner.

5.2.3.2 It is agreed that Contractor’s insurance shall be deemed primary with respect to any insurance or self insurance carried by Owner for liability arising out of operations under the Contract with Owner.

5.2.3.3 Owner, its officials, directors, employees, representatives, and volunteers are
5.2.3.4 A waiver of subrogation in favor of Owner shall be provided in all policies.

5.2.3.5 If Owner is damaged by the failure of Contractor (or Subcontractor) to maintain insurance as required herein and/or as further described in Owner’s Insurance Specifications Special Conditions, then Contractor shall bear all reasonable costs properly attributable to that failure.

5.2.4 Without limiting any of the other obligations or liabilities of Contractor, Contractor shall require each Subcontractor performing work under the Contract, at Subcontractor’s own expense, to maintain during the term of the Contract, the same stipulated minimum insurance including the required provisions and additional policy conditions as shown above. As an alternative, Contractor may include its Subcontractors as additional insureds on its own coverage as prescribed under these requirements. Contractor’s certificate of insurance shall note in such event that Subcontractors are included as additional insureds and that Contractor agrees to provide workers’ compensation for Subcontractors and their employees. Contractor shall obtain and monitor the certificates of insurance from each Subcontractor in order to assure compliance with the insurance requirements. Contractor must retain the certificates of insurance for the duration of the Contract plus five (5) years and shall have the responsibility of enforcing these insurance requirements among its Subcontractors. Owner shall be entitled, upon request and without expense, to receive copies of these certificates.

5.2.5 Workers’ compensation insurance coverage must meet the statutory requirements of Tex. Lab. Code § 401.011(44) and specific to construction projects for public entities as required by Tex. Lab. Code § 406.096.

5.2.5.1 Definitions:

5.2.5.1.1 Certificate of coverage ("certificate")- A copy of a certificate of insurance, a certificate of authority to self-insure issued by the commission, or a coverage agreement (DWC-81, DWC-82, DWC-83, or DWC-84), showing statutory workers’ compensation insurance coverage for the person's or entity's employees providing services on a project, for the duration of the project.

5.2.5.1.2 Duration of the project - includes the time from the beginning of the work on the project until the contractor's/person's work on the project has been completed and accepted by the governmental entity.

5.2.5.1.3 Persons providing services on the project ("subcontractor" in §406.096) – includes all persons or entities performing all or part of the services the contractor has undertaken to perform on the project, regardless of whether that person contracted directly with the contractor and regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontracts, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity which furnishes persons to provide services on the project. "Services" include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other service related to a project. "Services" does not include activities unrelated to the project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

5.2.5.2 The contractor shall provide coverage, based on proper reporting of classification codes
and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all employees of the contractor providing services on the project, for the duration of the project.

5.2.5.3 The Contractor must provide a certificate of coverage to the governmental entity prior to being awarded the contract.

5.2.5.4 If the coverage period shown on the contractor's current certificate of coverage ends during the duration of the project, the contractor must, prior to the end of the coverage period, file a new certificate of coverage with the governmental entity showing that coverage has been extended.

5.2.5.5 The contractor shall obtain from each person providing services on a project, and provide to the governmental entity:

(1) a certificate of coverage, prior to that person beginning work on the project, so the governmental entity will have on file certificates of coverage showing coverage for all persons providing services on the project; and

(2) no later than seven days after receipt by the contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project.

5.2.5.6 The contractor shall retain all required certificates of coverage for the duration of the project and for one year thereafter.

5.2.5.7 The contractor shall notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project.

5.2.5.8 The contractor shall post on each project site a notice, in the text, form and manner prescribed by the Texas Department of Insurance Division of Workers' Compensation, informing all persons providing services on the project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.

5.2.5.9 The contractor shall contractually require each person with whom it contracts to provide services on a project, to:

(1) provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all of its employees providing services on the project, for the duration of the project;

(2) provide to the contractor, prior to that person beginning work on the project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the project, for the duration of the project;

(3) provide the contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(4) obtain from each other person with whom it contracts, and provide to the contractor:

(a) a certificate of coverage, prior to the other person beginning work on the project; and
(b) a new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(5) retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

(6) notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project; and

(7) contractually require each person with whom it contracts, to perform as required by paragraphs (1) - (7), with the certificates of coverage to be provided to the person for whom they are providing services.

5.2.5.10 By signing this contract or providing or causing to be provided a certificate of coverage, the contractor is representing to the governmental entity that all employees of the contractor who will provide services on the project will be covered by workers' compensation coverage for the duration of the project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the commission's Division of Self-Insurance Regulation. Providing false or misleading information may subject the contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.

5.2.5.11 The contractor's failure to comply with any of these provisions is a breach of contract by the contractor which entitles the governmental entity to declare the contract void if the contractor does not remedy the breach within ten days after receipt of notice of breach from the governmental entity.

Article 6. Construction Documents, Coordination Documents, and Record Documents

6.1 Drawings and Specifications.

6.1.1 Copies Furnished. Contractor will be furnished, free of charge, the number of complete sets of the Drawings, Specifications, and addenda as provided in the Agreement or the Owner's Special Conditions. Additional complete sets of Drawings and Specifications, if requested, will be furnished at reproduction cost to the entity requesting such additional sets. Electronic copies of such documents will be provided to Contractor without charge.

6.1.2 Ownership of Drawings and Specifications. All Drawings, Specifications and copies thereof furnished by A/E are to remain A/E's property. These documents are not to be used on any other project, and with the exception of the Contract record set and electronic versions needed for warranty operations, are to be returned to the A/E, upon request, following completion of the Work.

6.1.3 Interrelation of Documents. The Contract Documents as referenced in the Contract between Owner and Contractor are complementary, and what is required by one shall be as binding as if required by all.

6.1.4 Resolution of Conflicts in Documents. Where conflicts may exist within the Contract Documents, the documents shall govern in the following order: (a) Change Orders, addenda, and written amendments to the Contract; (b) the Contract; (c) Owner's Special Conditions; (d) Drawings; (e) Specifications (but Specifications shall control over Drawings as to quality of
materials and installation); and f) other Contract Documents. Among other categories of documents having the same order of precedence, the term or provision that includes the latest date shall control. Contractor shall notify A/E and ODR for resolution of the issue prior to executing the Work in question.

6.1.5 Contractor’s Duty to Review Contract Documents. In order to facilitate its responsibilities for completion of the Work in accordance with and as reasonably inferable from the Contract Documents, prior to commencing the Work, Contractor shall examine and compare the Contract Documents, information furnished by Owner, relevant field measurements made by Contractor and any visible or reasonably anticipated conditions at the Site affecting the Work. This duty extends throughout the construction phase prior to commencing each particular work activity and/or system installation.

6.1.6 Discrepancies and Omissions in Drawings and Specifications.

6.1.6.1 Promptly report to ODR and to A/E the discovery of any apparent error, omission or inconsistency in the Contract Documents prior to execution of the Work.

6.1.6.2 It is recognized that Contractor is not acting in the capacity of a licensed design professional, unless it is performing as a Design-Build firm.

6.1.6.3 It is further recognized that Contractor’s examination of Contract Documents is to facilitate construction and does not create an affirmative responsibility to detect errors, omissions or inconsistencies or to ascertain compliance with applicable laws, building codes or regulations, unless it is performing as a Design-Build firm or a Construction Manager-at-Risk.

6.1.6.4 When performing as a Design-Build firm, Contractor has sole responsibility for discrepancies, errors, and omissions in the Drawings and Specifications.

6.1.6.5 When performing as a Construction Manager-at-Risk, Contractor has a shared responsibility with A/E for discovery and resolution of discrepancies, errors, and omissions in the Contract Documents. In such case, Contractor’s responsibility pertains to review, coordination, and recommendation of resolution strategies within budget constraints.

6.1.6.6 Contractor has no liability for errors, omissions, or inconsistencies unless Contractor knowingly failed to report a recognized problem to Owner or the Work is executed under a Design-Build or Construction Manager-at-Risk Contract as outlined above. Should Contractor fail to perform the examination and reporting obligations of these provisions, Contractor is responsible for avoidable costs and direct and/or consequential damages.

6.1.6.7 Owner does not warrant or make any representations as to the accuracy, suitability or completeness of any information furnished to Contractor by Owner or its representatives.

6.2 Requirements for Record Documents. Contractor shall:

6.2.1 Maintain at the Site one copy of all Drawings, Specifications, addenda, approved submittals, Contract modifications, and all Project correspondence. Keep current and maintain Drawings and Specifications in good order with postings and markings to record actual conditions of Work and show and reference all changes made during construction. Provide Owner and A/E access to these documents.

6.2.2 Maintain the Record Documents which reflect the actual field conditions and representations
of the Work performed, whether it be directed by addendum, Change Order or otherwise. Make available the Record Documents and all records prescribed herein for reference and examination by Owner and its representatives and agents.

6.2.3 Update the Record Documents at least monthly prior to submission of periodic partial pay estimates. Failure to maintain current Record Documents constitutes cause for denial of a progress payment otherwise due.

6.2.4 Prior to requesting Substantial Completion inspection Contractor shall furnish a copy of its marked-up Record Documents and a preliminary copy of each instructional manual, maintenance and operating manual, parts catalog, wiring diagrams, spare parts, specified written warranties and like publications, or parts for all installed equipment, systems, and like items and as described in the Contract Documents.

6.2.5 Once determined acceptable by ODR with input from A/E, provide one (1) reproducible copy and one (1) electronic media copy in a format acceptable to the ODR of all Record Documents, unless otherwise required by the Owner’s Special Conditions.

6.2.6 Contractor shall be responsible for updating the Record Documents for all Contractor initiated documents and changes to the Contract Documents due to coordination and actual field conditions, including RFIs.

6.2.7 A/E shall be responsible for updating the Record Documents for any addenda, Change Orders, A/E supplemental instructions and any other alterations to the Contract Documents generated by A/E or Owner.

Article 7. Construction Safety

7.1 General. It is the duty and responsibility of Contractor and all of its Subcontractors to be familiar with, enforce and comply with all requirements of Public Law No. 91-596, 29 U.S.C. § 651 et. seq., the Occupational Safety and Health Act of 1970, (OSHA) and all amendments thereto. Contractor shall prepare a safety plan specific to the Project and submit it to ODR and A/E prior to commencing Work. In addition, Contractor and all of its Subcontractors shall comply with all applicable laws and regulations of any public body having jurisdiction for safety of persons or property to protect them from damage, injury or loss and erect and maintain all necessary safeguards for such safety and protection.

7.2 Notices. Contractor shall provide notices as follows:

7.2.1 Notify owners of adjacent property including those that own or operate utility services and/or underground facilities, and utility owners, when prosecution of the Work may affect them or their facilities, and cooperate with them in the protection, removal, relocation and replacement, and access to their facilities and/or utilities.

7.2.2 Coordinate the exchange of material safety data sheets (MSDSs) or other hazard communication information required to be made available to or exchanged between or among employers at the site in connection with laws and regulations. Maintain a complete file of MSDSs for all materials in use on site throughout the construction phase and make such file available to Owner and its agents as requested.

7.3 Emergencies. In any emergency affecting the safety of persons or property, Contractor shall act to minimize, mitigate, and prevent threatened damage, injury or loss.

7.3.1 Have authorized agents of Contractor respond immediately upon call at any time of day or night when circumstances warrant the presence of Contractor to protect the Work or adjacent
property from damage or to take such action pertaining to the Work as may be necessary to provide for the safety of the public.

7.3.2 Give ODR and A/E prompt notice of all such events.

7.3.3 If Contractor believes that any changes in the Work or variations from Contract Documents have been caused by its emergency response, promptly notify Owner within seventy-two (72) hours of the emergency response event.

7.3.4 Should Contractor fail to respond, Owner is authorized to direct other forces to take action as necessary and Owner may deduct any cost of remedial action from funds otherwise due Contractor.

7.4 Injuries. In the event of an incident or accident involving outside medical care for an individual on or near the Work, Contractor shall notify ODR and other parties as may be directed promptly, but no later than twenty-four (24) hours after Contractor learns that an event required medical care.

7.4.1 Record the location of the event and the circumstances surrounding it, by using photography or other means, and gather witness statements and other documentation which describes the event.

7.4.2 Supply ODR and A/E with an incident report no later than thirty-six (36) hours after the occurrence of the event. In the event of a catastrophic incident (one (1) fatality or three (3) workers hospitalized), barricade and leave intact the scene of the incident until all investigations are complete. A full set of incident investigation documents, including facts, finding of cause, and remedial plans shall be provided within one (1) week after occurrence, unless otherwise directed by legal counsel. Contractor shall provide ODR with written notification within one week of such catastrophic event if legal counsel delays submission of full report.

7.5 Environmental Safety. Upon encountering any previously unknown potentially hazardous material, or other materials potentially contaminated by hazardous material, Contractor shall immediately stop work activities impacted by the discovery, secure the affected area, and notify ODR immediately.

7.5.1 Bind all Subcontractors to the same duty.

7.5.2 Upon receiving such notice, ODR will promptly engage qualified experts to make such investigations and conduct such tests as may be reasonably necessary to determine the existence or extent of any environmental hazard. Upon completion of this investigation, ODR will issue a written report to Contractor identifying the material(s) found and indicate any necessary steps to be taken to treat, handle, transport or dispose of the material.

7.5.3 Owner may hire third-party contractors to perform any or all such steps.

7.5.4 Should compliance with ODR’s instructions result in an increase in Contractor’s cost of performance, or delay the Work, Owner will make an equitable adjustment to the Contract Sum and/or the time of completion, and modify the Contract in writing accordingly.

7.6 Trenching Plan. When the project requires excavation which either exceeds a depth of four (4) feet, or results in any worker’s upper body being positioned below grade level, Contractor is required to submit a trenching plan to ODR prior to commencing trenching operations unless an engineered plan is part of the Contract Documents. The plan is required to be prepared and sealed by a professional engineer registered in the State of Texas, and hired or employed by Contractor or Subcontractor to perform the work. Said engineer cannot be anyone who is otherwise either directly or indirectly engaged on this project.
Article 8. Quality Control

8.1 Materials & Workmanship. Contractor shall execute Work in a good and workmanlike matter in accordance with the Contract Documents. Contractor shall develop and provide a quality control plan specific to this Project and acceptable to Owner. Where Contract Documents do not specify quality standards, complete and construct all Work in compliance with generally accepted construction industry standards. Unless otherwise specified, incorporate all new materials and equipment into the Work under the Contract.

8.2 Testing.

8.2.1 Owner is responsible for coordinating and paying for routine and special tests required to confirm compliance with quality and performance requirements, except as stated below or otherwise required by the Contract Documents.

8.2.2 Contractor shall provide the following testing as well as any other testing required of Contractor by the Specifications:

8.2.2.1 Any test of basic material or fabricated equipment included as part of a submittal for a required item in order to establish compliance with the Contract Documents.

8.2.2.2 Any test of basic material or fabricated equipment offered as a substitute for a specified item on which a test may be required in order to establish compliance with the Contract Documents.

8.2.2.3 Preliminary, start-up, pre-functional and operational testing of building equipment and systems as necessary to confirm operational compliance with requirements of the Contract Documents.

8.2.2.4 All subsequent tests on original or replaced materials conducted as a result of prior testing failure.

8.2.3 All testing shall be performed in accordance with standard test procedures by an accredited laboratory, or special consultant as appropriate, acceptable to Owner. Results of all tests shall be provided promptly to ODR, A/E, and Contractor.

8.2.4 Non-Compliance (Test Results). Should any of the tests indicate that a material and/or system does not comply with the Contract requirements, the burden of proof remains with Contractor, subject to:

8.2.4.1 Contractor selection and submission of the laboratory for Owner acceptance.

8.2.4.2 Acceptance by Owner of the quality and nature of tests.

8.2.4.3 All tests taken in the presence of A/E and/or ODR, or their representatives.

8.2.4.4 If tests confirm that the material/systems comply with Contract Documents, Owner will pay the cost of the test.

8.2.4.5 If tests reveal noncompliance, Contractor will pay those laboratory fees and costs of that particular test and all future tests, of that failing Work, necessary to eventually confirm compliance with Contract Documents.

8.2.4.6 Proof of noncompliance with the Contract Documents will make Contractor liable for any corrective action which ODR determines appropriate, including complete
removal and replacement of non-compliant work or material.

8.2.5 Notice of Testing. Contractor shall give ODR and A/E timely notice of its readiness and the date arranged so ODR and A/E may observe such inspection, testing, or approval.

8.2.6 Test Samples. Contractor is responsible for providing Samples of sufficient size for test purposes and for coordinating such tests with their Work Progress Schedule to avoid delay.

8.2.7 Covering Up Work. If Contractor covers up any Work without providing Owner an opportunity to inspect, Contractor shall, if requested by ODR, uncover and recover the work at Contractor’s expense.

8.3 Submittals.

8.3.1 Contractor’s Submittals. Contractor shall submit with reasonable promptness consistent with the Project schedule and in orderly sequence all Shop Drawings, Samples, or other information required by the Contract Documents, or subsequently required by Change Order. Prior to submitting, Contractor shall review each submittal for general compliance with Contract Documents and approve submittals for review by A/E and Owner by an approval stamp affixed to each copy. Submittal data presented without Contractor’s stamp of approval will be returned without review or comment. Any delay resulting from Contractor’s failure to certify approval of the Submittal is Contractor’s responsibility.

8.3.1.1 Contractor shall within twenty-one (21) days of the effective date of the Notice To Proceed with construction, submit to ODR and A/E, a submittal schedule/register, organized by specification section, listing all items to be furnished for review and approval by A/E and Owner. The list shall include Shop Drawings, manufacturer’s literature, certificates of compliance, materials Samples, materials colors, guarantees, and all other items identified throughout the Specifications.

8.3.1.2 Contractor shall indicate the type of item, Contract requirements reference, and Contractor’s scheduled dates for submitting the item along with the requested dates for approval answers from A/E and Owner. The submittal register shall indicate the projected dates for procurement of all included items and shall be updated at least monthly with actual approval and procurement dates. Contractor’s Submittal Register must be reasonable in terms of the review time for complex submittals. Contractor’s submittal schedule must be consistent with the Work Progress Schedule and identify critical submittals. Show and allow a minimum of fifteen (15) days duration after receipt by A/E and ODR for review and approval. If re-submittal required, allow a minimum of an additional fifteen (15) days for review. Submit the updated Submittal Register with each request for progress payment. Owner may establish routine review procedures and schedules for submittals at the preconstruction conference and/or elsewhere in the Contract Documents. If Contractor fails to update and provide the Submittal Register as required, Owner may, after seven (7) days notice to Contractor withhold a reasonable sum of money that would otherwise be due Contractor.

8.3.1.3 Contractor shall coordinate the Submittal Register with the Work Progress Schedule. Do not schedule Work requiring a submittal to begin prior to scheduling review and approval of the related submittal. Revise and/or update both schedules monthly to ensure consistency and current project data. Provide to ODR the updated Submittal Register and schedule with each application for progress payment. Refer to requirements for the Work Progress Schedule for inclusion of procurement activities therein. Regardless, the Submittal Register shall identify dates submitted and returned and shall be used to confirm status and disposition of particular items submitted, including approval or other action taken and other
information not conveniently tracked through the Work Progress Schedule.

8.3.1.4 By submitting Shop Drawings, Samples or other required information, Contractor represents that it has determined and verified all applicable field measurements, field construction criteria, materials, catalog numbers and similar data; and has checked and coordinated each Shop Drawing and Sample with the requirements of the Work and the Contract Documents.

8.3.2 **Review of Submittals.** A/E and ODR review is only for conformance with the design concept and the information provided in the Contract Documents. Responses to submittals will be in writing. The approval of a separate item does not indicate approval of an assembly in which the item functions. The approval of a submittal does not relieve Contractor of responsibility for any deviation from the requirements of the Contract unless Contractor informs A/E and ODR of such deviation in a clear, conspicuous, and written manner on the submittal transmittal and at the time of submission, and obtains Owner’s written specific approval of the particular deviation.

8.3.3 **Correction and Resubmission.** Contractor shall make any corrections required to a submittal and resubmit the required number of corrected copies promptly so as to avoid delay, until submittal approval. Direct attention in writing to A/E and ODR, when applicable, to any new revisions other than the corrections requested on previous submissions.

8.3.4 **Limits on Shop Drawing Review.** Contractor shall not commence any Work requiring a submittal until review of the submittal under Subsection 8.3.2. Construct all such work in accordance with reviewed submittals. Comments incorporated as part of the review in Subsection 8.3.2 of Shop Drawings and Samples is not authorization to Contractor to perform extra work or changed work unless authorized through a Change Order. A/E’s and ODR’s review, if any, does not relieve Contractor from responsibility for defects in the Work resulting from errors or omissions of any kind on the submittal, regardless of any approval action.

8.3.5 **No Substitutions Without Approval.** ODR and A/E may receive and consider Contractor’s request for substitution when Contractor agrees to reimburse Owner for review costs and satisfies the requirements of this section. If Contractor does not satisfy these conditions, ODR and A/E will return the request without action except to record noncompliance with these requirements. Owner will not consider the request if Contractor cannot provide the product or method because of failure to pursue the Work promptly or coordinate activities properly. Contractor’s request for a substitution may be considered by ODR and A/E when:

8.3.5.1 The Contract Documents do not require extensive revisions; and

8.3.5.2 Proposed changes are in keeping with the general intent of the Contract Documents and the design intent of A/E and do not result in an increase in cost to Owner; and

8.3.5.3 The request is timely, fully documented, properly submitted and one or more of the following apply:

8.3.5.3.1 Contractor cannot provide the specified product, assembly or method of construction within the Contract Time;

8.3.5.3.2 The request directly relates to an “or-equal” clause or similar language in the Contract Documents;

8.3.5.3.3 The request directly relates to a “product design standard” or “performance standard” clause in the Contract Documents;
8.3.5.3.4 The requested substitution offers Owner a substantial advantage in cost, time, energy conservation or other considerations, after deducting additional responsibilities Owner must assume;

8.3.5.3.5 The specified product or method of construction cannot receive necessary approval by an authority having jurisdiction, and ODR can approve the requested substitution;

8.3.5.3.6 Contractor cannot provide the specified product, assembly or method of construction in a manner that is compatible with other materials and where Contractor certifies that the substitution will overcome the incompatibility;

8.3.5.3.7 Contractor cannot coordinate the specified product, assembly or method of construction with other materials and where Contractor certifies they can coordinate the proposed substitution; or

8.3.5.3.8 The specified product, assembly or method of construction cannot provide a warranty required by the Contract Documents and where Contractor certifies that the proposed substitution provides the required warranty.

8.3.6 Unauthorized Substitutions at Contractor’s Risk. Contractor is financially responsible for any additional costs or delays resulting from unauthorized substitution of materials, equipment or fixtures other than those specified. Contractor shall reimburse Owner for any increased design or contract administration costs resulting from such unauthorized substitutions.

8.4 Field Mock-up.

8.4.1 Mock-ups shall be constructed prior to commencement of a specified scope of work to confirm acceptable workmanship.

8.4.1.1 As a minimum, field mock-ups shall be constructed for roofing systems, exterior veneer / finish systems, glazing systems, and any other Work requiring a mock-up as identified throughout the Contract Documents. Mock-ups for systems not part of the Project scope shall not be required.

8.4.1.2 Mock-ups may be incorporated into the Work if allowed by the Contract Documents and if acceptable to ODR. If mock-ups are freestanding, they shall remain in place until otherwise directed by Owner.

8.4.1.3 Contractor shall include field mock-ups in their Work Progress Schedule and shall notify ODR and A/E of readiness for review sufficiently in advance to coordinate review without delay.

8.5 Inspection During Construction.

8.5.1 Contractor shall provide sufficient, safe, and proper facilities, including equipment as necessary for safe access, at all reasonable times for observation and/or inspection of the Work by Owner and its agents.

8.5.2 Contractor shall not cover up any Work with finishing materials or other building components prior to providing Owner and its agents an opportunity to perform an inspection of the Work.

8.5.2.1 Should corrections of the Work be required for approval, Contractor shall not over
8.5.2.2 Contractor shall provide notification of at least five (5) working days or otherwise as mutually agreed, to ODR of the anticipated need for a cover-up inspection. Should ODR fail to make the necessary inspection within the agreed period, Contractor may proceed with cover-up Work, but is not relieved of responsibility for Work to comply with requirements of the Contract Documents.

Article 9. Construction Schedules

9.1 Contract Time. TIME IS AN ESSENTIAL ELEMENT OF THE CONTRACT. The Contract Time is the time between the dates indicated in the Notice to Proceed for commencement of the Work and for achieving Substantial Completion. The Contract Time can be modified only by Change Order. Failure to achieve Substantial Completion within the Contract Time or as otherwise agreed to in writing will cause damage to Owner and may subject Contractor to liquidated damages as provided in the Contract Documents. If Contractor fails to achieve Final Completion in a reasonable time after Substantial Completion, Contractor shall be responsible for Owner’s damages including, but not limited to, additional inspection, project management, and maintenance cost to the extent caused by Contractor’s failure to achieve Final Completion.

9.2 Notice to Proceed. Owner will issue a Notice to Proceed which shall state the dates for beginning Work and for achieving Substantial Completion of the Work.

9.3 Work Progress Schedule. Refer to Owner’s Special Conditions and Division 1 of the Specifications for additional schedule requirements. Unless indicated otherwise in those documents, Contractor shall submit their initial Work Progress Schedule for the Work in relation to the entire Project not later than twenty-one (21) calendar days after the effective date of the Notice to Proceed to ODR and A/E. Unless otherwise indicated in the Contract Documents, the Work Progress Schedule shall be computerized Critical Path Method (CPM) with fully editable logic. This initial schedule shall indicate the dates for starting and completing the various aspects required to complete the Work, including mobilization, procurement, installation, testing, inspection, delivery of Close-out Documents and acceptance of all the Work of the Contract. When acceptable to Owner, the initially accepted schedule shall be the Baseline Schedule for comparison to actual conditions throughout the Contract duration. Note: This article pertains to construction phase schedules. Additional requirements for design phase scheduling for Construction Manager-at-Risk and Design-Build contracts are outlined in Division 1 Project Planning and Scheduling Specifications.

9.3.1 Schedule Requirements. Contractor shall submit electronic and paper copy of the initial Work Progress Schedule reflecting accurate and reliable representations of the planned progress of the Work, the Work to date if any, and of Contractor’s actual plans for its completion. Contractor shall organize and provide adequate detail so the schedule is capable of measuring and forecasting the effect of delaying events on completed and uncompleted activities.

9.3.1.1 Contractor shall re-submit initial schedule as required to address review comments from A/E and ODR until such schedule is accepted as the Baseline Schedule.

9.3.1.2 Submittal of a schedule, schedule revision or schedule update constitutes Contractor’s representation to Owner of the accurate depiction of all progress to date and that Contractor will follow the schedule as submitted in performing the Work.

9.3.2 Schedule Updates. Contractor shall update the Work Progress Schedule and the Submittal Register monthly, as a minimum, to reflect progress to date and current plans for completing the Work, while maintaining original schedule as Baseline Schedule and submit paper and electronic copies of the update to A/E and ODR as directed, but as a minimum with each
request for payment. Owner has no duty to make progress payments unless accompanied by the updated Work Progress Schedule. Show the anticipated date of completion reflecting all extensions of time granted through Change Order as of the date of the update. Contractor may revise the Work Progress Schedule when in Contractor’s judgment it becomes necessary for the management of the Work. Contractor shall identify all proposed changes to schedule logic to Owner and to A/E via an executive summary accompanying the updated schedule for review prior to final implementation of revisions into a revised Baseline Schedule. Schedule changes that materially impact Owner’s operations shall be communicated promptly to ODR and shall not be incorporated into the revised Baseline Schedule without ODR’s consent.

9.3.3 The Work Progress Schedule is for Contractor’s use in managing the Work and submittal of the schedule, and successive updates or revisions, is for the information of Owner and to demonstrate that Contractor has complied with requirements for planning the Work. Owner’s acceptance of a schedule, schedule update or revision constitutes Owner’s agreement to coordinate its own activities with Contractor’s activities as shown on the schedule.

9.3.3.1 Acceptance of the Work Progress Schedule, or update and/or revision thereto does not indicate any approval of Contractor’s proposed sequences and duration.

9.3.3.2 Acceptance of a Work Progress Schedule update or revision indicating early or late completion does not constitute Owner’s consent, alter the terms of the Contract, or waive either Contractor’s responsibility for timely completion or Owner’s right to damages for Contractor’s failure to do so.

9.3.3.3 Contractor’s scheduled dates for completion of any activity or the entire Work do not constitute a change in terms of the Contract. Change Orders are the only method of modifying the Substantial Completion Date(s) and Contract Time.

9.4 Ownership of Float. Unless indicated otherwise in the Contract Documents, Contractor shall develop its schedule, pricing, and execution plan to provide a minimum of ten (10) percent total float at acceptance of the Baseline Schedule. Float time contained in the Work Progress Schedule is not for the exclusive benefit of Contractor or Owner, but belongs to the Project and may be consumed by either party. Before Contractor uses any portion of the float Contractor must submit a written request to do so to the Owner and receive Owner’s written authorization to use the float. Owner’s approval shall not be unreasonably withheld.

9.5 Completion of Work. Contractor is accountable for completing the Work within the Contract Time stated in the Contract, or as otherwise amended by Change Order.

9.5.1 If, in the judgment of Owner, the work is behind schedule and the rate of placement of work is inadequate to regain scheduled progress to insure timely completion of the entire work or a separable portion thereof, Contractor, when so informed by Owner, shall immediately take action to increase the rate of work placement by:

9.5.1.1 An increase in working forces.
9.5.1.2 An increase in equipment or tools.
9.5.1.3 An increase in hours of work or number of shifts.
9.5.1.4 Expedite delivery of materials.
9.5.1.5 Other action proposed if acceptable to Owner.

9.5.2 Within ten (10) days after such notice from ODR, Contractor shall notify ODR in writing of the specific measures taken and/or planned to increase the rate of progress. Contractor shall
include an estimate as to the date of scheduled progress recovery and an updated Work Progress Schedule illustrating Contractor’s plan for achieving timely completion of the Project. Should ODR deem the plan of action inadequate, Contractor shall take additional steps or make adjustments as necessary to its plan of action until it meets with ODR’s approval.

9.6 Modification of the Contract Time.

9.6.1 Delays and extension of time as hereinafter described are valid only if executed in accordance with provisions set forth in Article 11.

9.6.2 When a delay defined herein as excusable prevents Contractor from completing the Work within the Contract Time, Contractor is entitled to an extension of time. Owner will make an equitable adjustment and extend the number of days lost because of excusable delay or Weather Days, as measured by Contractor’s progress schedule. All extensions of time will be granted in calendar days. In no event, however, will an extension of time be granted for delays that merely extend the duration of non-critical activities, or which only consume float without delaying the project Substantial Completion date(s).

9.6.2.1 A “Weather Day” is a day on which Contractor’s current schedule indicates Work is to be done, and on which inclement weather and related site conditions prevent Contractor from performing seven (7) hours of Work between the hours of 7:00 a.m. and 6:00 p.m. Weather days are excusable delays. When weather conditions at the site prevent work from proceeding, Contractor shall immediately notify ODR for confirmation of the conditions. At the end of each calendar month, Contractor shall submit to ODR and A/E a list of Weather Days occurring in that month along with documentation of the impact on critical activities. Based on confirmation by ODR, any time extension granted will be issued by Change Order. If Contractor and Owner cannot agree on the time extension, Owner may issue a ULCO for fair and reasonable time extension.

9.6.2.2 Excusable Delay. Contractor is entitled to an equitable adjustment of the Contract Time, issued via change order, for delays caused by the following:

9.6.2.2.1 Errors, omissions and imperfections in design, which A/E corrects by means of changes in the Drawings and Specifications.

9.6.2.2.2 Unanticipated physical conditions at the Site, which A/E corrects by means of changes to the Drawings and Specifications or for which ODR directs changes in the Work identified in the Contract Documents.

9.6.2.2.3 Changes in the Work that effect activities identified in Contractor’s schedule as “critical” to completion of the entire Work, if such changes are ordered by ODR or recommended by A/E and ordered by ODR.

9.6.2.2.4 Suspension of Work for unexpected natural events (sometimes called “acts of God”), civil unrest, strikes or other events which are not within the reasonable control of Contractor.

9.6.2.2.5 Suspension of Work for convenience of ODR, which prevents Contractor from completing the Work within the Contract Time.

9.6.3 Contractor’s relief in the event of such delays is the time impact to the critical path as determined by analysis of Contractor’s schedule. In the event that Contractor incurs
additional direct costs because of the excusable delays other than described in Subparagraph 9.6.2.2.4 and within the reasonable control of Owner, the Contract price and Contract Time are to be equitably adjusted by Owner pursuant to the provisions of Article 11.

9.7  No Damages for Delay. An extension of the Contract Time shall be the sole remedy of Contractor for delays in performance of the Work, whether or not such delays are foreseeable, except for delays caused solely by acts of Owner that constitute intentional interference with Contractor’s performance of the Work and then only to the extent such acts continue after Contractor notifies Owner in writing of such interference. For delays caused by any act(s) other than the sole intentional interference of Owner, Contractor shall not be entitled to any compensation or recovery of any damages including, without limitation, consequential damages, lost opportunity costs, impact damages, loss of productivity, or other similar damages. Owner’s exercise of any of its rights or remedies under the Contract including, without limitation, ordering changes in the Work or directing suspension, rescheduling, or correction of the Work, shall not be construed as intentional interference with Contractor’s performance of the Work regardless of the extent or frequency of Owner’s exercise of such rights or remedies.

9.8  Concurrent Delay. When the completion of the Work is simultaneously delayed by an excusable delay and a delay arising from a cause not designated as excusable, Contractor may not be entitled to a time extension for the period of concurrent delay.

9.9  Other Time Extension Requests. Time extensions requested in association with changes to the Work directed or requested by Owner shall be included with Contractor’s proposed costs for such change. Time extensions requested for inclement weather are covered by Paragraph 9.6.2.1 above. If Contractor believes that the completion of the Work is delayed by a circumstance other than for changes directed to the Work or weather, they shall give ODR written notice, stating the nature of the delay and the activities potentially affected, within five (5) days after the onset of the event or circumstance giving rise to the excusable delay. Contractor shall provide sufficient written evidence to document the delay. In the case of a continuing cause of delay, only one notice of claim is necessary. State claims for extensions of time in numbers of whole or half days.

9.9.1  Within ten (10) days after the cessation of the delay, Contractor shall formalize its request for extension of time in writing to include a full analysis of the schedule impact of the delay and substantiation of the excusable nature of the delay. All changes to the Contract Time or made as a result of such claims is by Change Order, as set forth in Article 11.

9.9.2  No extension of time releases Contractor or the Surety furnishing a performance or payment bond from any obligations under the Contract or such a bond. Those obligations remain in full force until the discharge of the Contract.

9.9.3  Contents of Time Extension Requests. Contractor shall provide with each Time Extension Request a quantitative demonstration of the impact of the delay on project completion time, based on the Work Progress Schedule. Contractor shall include with Time Extension Requests a reasonably detailed narrative setting forth:

9.9.3.1  The nature of the delay and its cause; the basis of Contractor’s claim of entitlement to a time extension.

9.9.3.2  Documentation of the actual impacts of the claimed delay on the critical path indicated in Contractor’s Work Progress Schedule, and any concurrent delays.

9.9.3.3  Description and documentation of steps taken by Contractor to mitigate the effect of the claimed delay, including, when appropriate, the modification of the Work Progress Schedule.

9.9.4  Owner’s Response. Owner will respond to the Time Extension Request by providing to
Contractor written notice of the number of days granted, if any, and giving its reason if this number differs from the number of days requested by Contractor.

9.9.4.1 Owner will not grant time extensions for delays that do not affect the Contract Substantial Completion date.

9.9.4.2 Owner will respond to each properly submitted Time Extension Request within fifteen (15) days following receipt. If Owner cannot reasonably make a determination about Contractor’s entitlement to a time extension within that time, Owner will notify Contractor in writing. Unless otherwise agreed by Contractor, Owner has no more than fifteen (15) additional days to prepare a final response. If Owner fails to respond within forty-five (45) days from the date the Time Extension Request is received, Contractor’s request for a time extension shall be deemed rejected by Owner.

9.10 Failure to Complete Work Within the Contract Time. **TIME IS AN ESSENTIAL ELEMENT OF THE CONTRACT.** Contractor’s failure to substantially complete the Work within the Contract Time or to achieve Substantial Completion as required will cause damage to Owner. These damages **shall may** be liquidated by agreement of Contractor and Owner, in the amount per day as set forth in the Contract Documents.

9.11 Liquidated Damages. Owner may collect liquidated damages due from Contractor directly or indirectly by reducing the Contract Sum in the amount of liquidated damages stated in the Agreement or the Owner’s Special Conditions.

**Article 10. Payments**

10.1 Schedule of Values. Contractor shall submit to ODR and A/E for acceptance a Schedule of Values accurately itemizing material and labor for the various classifications of the Work based on the organization of the specification sections and of sufficient detail acceptable to ODR. The accepted Schedule of Values will be the basis for the progress payments under the Contract.

10.1.1 No progress payments will be made prior to receipt and acceptance of the Schedule of Values, provided in such detail as required by ODR, and submitted not less than twenty-one (21) days prior to the first request for payment. The Schedule of Values shall follow the order of trade divisions of the Specifications and include itemized costs for general conditions, costs for preparing close out, close-out documents, fees, contingencies, and Owner cash allowances, if applicable, so that the sum of the items will equal the Contract price. As appropriate, assign each item labor and/or material values, the subtotal thereof equaling the value of the work in place when complete.

10.1.1.1 Owner requires that the Work items be inclusive of the cost of the Work items only. Any contract markups for overhead and profit, general conditions, etc., shall be contained within separate line items for those specific purposes which shall be divided into at least two (2) lines, one (1) for labor and one (1) for materials.

10.1.2 Contractor shall retain a copy of all worksheets used in preparation of its bid or proposal, supported by a notarized statement that the worksheets are true and complete copies of the documents used to prepare the bid or proposal. Make the worksheets available to ODR at the time of Contract execution. Thereafter Contractor shall grant Owner during normal business hours access to said copy of worksheets at any time during the period commencing upon execution of the Contract and ending one year after final payment.

10.2. Progress Payments. Contractor will receive periodic progress payments for Work performed, materials in place, suitably stored on Site, or as otherwise agreed to by Owner and Contractor. Payment is not due until receipt by ODR or his designee of a correct and complete Pay Application in electronic
and/or hard copy format as set forth in the Agreement or the Owner’s Special Conditions, and certified by A/E. Progress payments are made provisionally and do not constitute acceptance of work not in accordance with the Contract Documents. Owner will not process progress payment applications for Change Order Work until all parties execute the Change Order.

10.2.1 Preliminary Pay Worksheet. Once each month that a progress payment is to be requested, the Contractor shall submit to A/E and ODR a complete, clean copy of a preliminary pay worksheet or preliminary pay application, to include the following:

10.2.1.1 Contractor’s estimate of the amount of Work performed, labor furnished and materials incorporated into the Work, using the established Schedule of Values;

10.2.1.2 An updated Work Progress Schedule including the executive summary and all required schedule reports;

10.2.1.3 HUB subcontracting plan Progress Assessment Report as required in Paragraph 4.2.5.1;

10.2.1.4 Such additional documentation as Owner may require as set forth in the elsewhere in the Contract Documents; and

10.2.1.5 Construction payment affidavit.

10.2.2 Contractor’s Application for Payment. As soon as practicable, but in no event later than seven (7) days after receipt of the preliminary pay worksheet, A/E and ODR will meet with Contractor to review the preliminary pay worksheet and to observe the condition of the Work. Based on this review, ODR and A/E may require modifications to the preliminary pay worksheet prior to the submittal of an Application for Payment, and will promptly notify Contractor of revisions necessary for approval. As soon as practicable, Contractor shall submit its Application for Payment on the appropriate and completed form, reflecting the required modifications to the Schedule of Values required by A/E and/or ODR. Attach all additional documentation required by ODR and/or A/E, as well as an affidavit affirming that all payrolls, bills for labor, materials, equipment, subcontracted work and other indebtedness connected with Contractor’s Application for Payment are paid or will be paid within the time specified in Tex. Gov’t Code, Chapter 2251. No Application for Payment is complete unless it fully reflects all required modifications, and attaches all required documentation including Contractor’s affidavit.

10.2.3 Certification by Architect/Engineer. Within five (5) days or earlier following A/E’s receipt of Contractor’s formal Application for Payment, A/E will review the Application for Payment for completeness, and forward it to ODR. A/E will certify that the application is complete and payable, or that it is incomplete, stating in particular what is missing. If the Application for Payment is incomplete, Contractor shall make the required corrections and resubmit the Application for Payment for processing.

10.3 Owner’s Duty to Pay. Owner has no duty to pay the Contractor except on receipt by ODR of: 1) a complete Application for Payment certified by A/E; 2) Contractor’s updated Work Progress Schedule; and 3) confirmation that Contractor has maintained and updated the Record Documents kept at the Site.

10.3.1 Payment for stored materials and/or equipment confirmed by Owner and A/E to be on-site or otherwise properly stored is limited to eighty-five (85) percent of the invoice price or eighty-five (85) percent of the scheduled value for the materials or equipment, whichever is less.

10.3.2 Retainage. Owner will withhold from each progress payment, as retainage, five (5) percent of the total earned amount, the amount authorized by law, or as otherwise set forth in the Owner’s Special Conditions. Retainage is managed in conformance with Tex. Gov’t Code,
Chapter 2252, Subchapter B.

10.3.2.1 Contractor shall provide written consent of its surety for any request for reduction or release of retainage.

10.3.2.2 At least sixty-five (65) percent of the Contract, or such other discrete Work phase as set forth in Subsection 12.1.6 or Work package delineated in the Contract Documents, must be completed before Owner can consider a retainage reduction or release.

10.3.2.3 Contractor shall not withhold retainage from their Subcontractors and suppliers in amounts that are any percentage greater than that withheld in its Contract with Owner under this subsection, unless otherwise acceptable to Owner.

10.3.3 Price Reduction to Cover Loss. Owner may reduce any Application for Payment, prior to payment to the extent necessary to protect Owner from loss on account of actions of Contractor including, but not limited to, the following:

10.3.3.1 Defective or incomplete Work not remedied;

10.3.3.2 Damage to Work of a separate Contractor;

10.3.3.3 Failure to maintain scheduled progress or reasonable evidence that the Work will not be completed within the Contract Time;

10.3.3.4 Persistent failure to carry out the Work in accordance with the Contract Documents;

10.3.3.5 Reasonable evidence that the Work cannot be completed for the unpaid portion of the Contract Sum;

10.3.3.6 Assessment of fines for violations of prevailing wage rate law; or

10.3.3.7 Failure to include the appropriate amount of retainage for that periodic progress payment.

10.3.4 Title to all material and Work covered by progress payments transfers to Owner upon payment.

10.3.4.1 Transfer of title to Owner does not relieve Contractor and its Subcontractors of the sole responsibility for the care and protection of materials and Work upon which payments have been made until final acceptance, or the restoration of any damaged Work, or waive the right of Owner to require the fulfillment of all the terms of the Contract.

10.4 Progress Payments. Progress payments to Contractor do not release Contractor or its surety from any obligations under the Contract.

10.4.1 Upon Owner’s request, Contractor shall furnish manifest proof of the status of Subcontractor’s accounts in a form acceptable to Owner.

10.4.2 Pay estimate certificates must be signed by a corporate officer or a representative duly authorized by Contractor.

10.4.3 Provide copies of bills of lading, invoices, delivery receipts or other evidence of the location and value of such materials in requesting payment for materials.
10.4.4 For purposes of Tex. Gov’t Code § 2251.021(a)(2), the date the performance of service is complete is the date when ODR approves the Application for Payment.

10.5 Off-Site Storage. With prior approval by Owner and in the event Contractor elects to store materials at an off-site location, abide by the following conditions, unless otherwise agreed to in writing by Owner.

10.5.1 Store materials in a commercial warehouse meeting the criteria stated below.

10.5.2 Provide insurance coverage adequate not only to cover materials while in storage, but also in transit from the off-site storage areas to the Project Site. Copies of duly authenticated certificates of insurance, made out to insure the State agency which is signatory to the Contract, must be filed with Owner’s representative.

10.5.3 Inspection by Owner’s representative is allowed at any time. Owner’s inspectors must be satisfied with the security, control, maintenance, and preservation measures.

10.5.4 Materials for this Project are physically separated and marked for the Project in a sectioned-off area. Only materials which have been approved through the submittal process are to be considered for payment.

10.5.5 Owner reserves the right to reject materials at any time prior to final acceptance of the complete Contract if they do not meet Contract requirements regardless of any previous progress payment made.

10.5.6 With each monthly payment estimate, submit a report to ODR and A/E listing the quantities of materials already paid for and still stored in the off-site location.

10.5.7 Make warehouse records, receipts and invoices available to Owner’s representatives, upon request, to verify the quantities and their disposition.

10.5.8 In the event of Contract termination or default by Contractor, the items in storage off-site, upon which payment has been made, will be promptly turned over to Owner or Owner’s agents at a location near the jobsite as directed by ODR. The full provisions of performance and payment bonds on this Project cover the materials off-site in every respect as though they were stored on the Project Site.

10.6 Time for Payment by Contractor Pursuant to Tex. Gov’t Code § 2255.022.

10.6.1 Contractor who receives a payment from a governmental entity shall pay Subcontractor the appropriate share of the payment not later than the tenth (10th) day after the date Contractor receives the payment.

10.6.2 The appropriate share is overdue on the eleventh (11th) day after the date Contractor receives the payment.

Article 11. Changes

11.1 Change Orders. A Change Order issued after execution of the Contract is a written order to Contractor, signed by ODR, Contractor, and A/E, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time can only be changed by Change Order. A Change Order signed by Contractor indicates his agreement therewith, including the adjustment in the Contract Sum and/or the Contract Time. ODR may issue a written authorization for Contractor to proceed with Work of a Change Order in advance of final execution by all parties in accordance with Section 11.9.
11.1.1 Owner, without invalidating the Contract and without approval of Contractor’s Surety, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, and the Contract Sum and the Contract Time will be adjusted accordingly. All such changes in the Work shall be authorized by Change Order or ULCO, and shall be performed under the applicable conditions of the Contract Documents. If such changes cause an increase or decrease in Contractor’s cost of, or time required for, performance of the Contract, an equitable adjustment shall be made and confirmed in writing in a Change Order or a ULCO.

11.1.2 Owner and Contractor acknowledge and agree that the Specifications and Drawings may not be complete or free from errors, omissions and imperfections and that they may require changes or additions in order for the Work to be completed to the satisfaction of Owner. Therefore, any minor errors, omissions or imperfections in the Specifications or Drawings, or any changes in or additions to the Specifications or Drawings to correct minor errors or omissions or to the Work ordered by Owner shall not constitute or give rise to any claim, demand or cause of action of any nature whatsoever in favor of Contractor, whether for breach of Contract, or otherwise. However, should the nature of the errors or omissions necessitate substantial changes in the Work such that a Change Order is appropriate, Owner shall be liable to Contractor for the sum stated to be due Contractor in any Change Order approved and signed by both parties. The sum established in any Change Order, together with any extension of time contained in said Change Order, shall constitute full compensation to Contractor for the changes in the Work described in the Change Order, as permitted under Tex. Gov’t Code, Chapter 2260.

11.1.3 Procedures for administration of Change Orders shall be established by Owner and stated in the Owner’s Special Conditions, or elsewhere in the Contract Documents.

11.1.4 No verbal order, verbal statement, or verbal direction of Owner or his duly appointed representative shall be treated as a change under this article or entitle Contractor to an adjustment.

11.1.5 Contractor agrees that Owner or any of its duly authorized representatives shall have access and the right to examine any directly pertinent books, documents, papers, and records of Contractor. Further, Contractor agrees to include in all its subcontracts a provision to the effect that Subcontractor agrees that Owner or any of its duly authorized representatives shall have access to and the right to examine any directly pertinent books, documents, papers and records of such Subcontractor relating to any claim arising from the Contract, whether or not the Subcontractor is a party to the claim. The period of access and examination described herein which relates to appeals under the Disputes article of the Contract, litigation, or the settlement of claims arising out of the performance of the Contract shall continue until final disposition of such claims, appeals or litigation.

11.2 Unit Prices. If unit prices are stated in the Contract Documents or subsequently agreed upon and if the quantities originally contemplated in setting the unit prices 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 Owner or Contractor, the applicable unit prices shall be equitably adjusted as provided in the Owner’s Special Conditions or as agreed to by the parties and incorporated into a Change Order.

11.3 Claims for Additional Costs.

11.3.1 If Contractor wishes to make a claim for an increase in the Contract Sum not related to a requested change, it shall give Owner and A/E written notice thereof within twenty-one (21) days after the occurrence of the event or discovery of any conditions giving rise to such claim. Contractor must notify Owner and A/E before proceeding to execute any Work considered to add additional cost or time, except in an emergency endangering life or property in which case Contractor shall act in accordance with Subsection 7.2.1., and failure to provide the
required notice will invalidate any subsequent notice or claim for additional cost or time for the Work. If Owner and Contractor cannot agree on the amount of the adjustment in the Contract Sum, it shall be determined as set forth under Article 15. Any change in the Contract Sum resulting from such claim shall be authorized by a Change Order or a ULCO.

11.3.2 If Contractor claims that additional cost is involved because of, but not limited to, 1) any written interpretation of the Contract Documents, 2) any order by Owner to stop the Work pursuant to Article 14 where Contractor was not at fault, or 3) any written order for a minor change in the Work issued pursuant to Section 11.4, Contractor shall make such claim as provided in Subsection 11.3.1.

11.3.3 Should Contractor or his Subcontractors fail to call attention of A/E to discrepancies or omissions in the Contract Documents, but claim additional costs for corrective Work after Contract award, Owner may assume intent to circumvent competitive bidding for necessary corrective Work. In such case, Owner may choose to let a separate Contract for the corrective Work, or issue a ULCO to require performance by Contractor. Claims for time extensions or for extra cost resulting from delayed notice of patent Contract Document discrepancies or omissions will not be considered by Owner.

11.4 Minor Changes. A/E, with concurrence of ODR, will have authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time. Such changes shall be effected by written order which Contractor shall carry out promptly and record on the Record Documents.

11.5 Concealed Site Conditions. Contractor is responsible for visiting the Site and being familiar with local conditions such as the location, accessibility, and general character of the Site and/or building. If, in the performance of the Contract, subsurface, latent, or concealed conditions at the Site are found to be materially different from the information included in the Contract Documents, or if unknown conditions of an unusual nature are disclosed differing materially from the conditions usually inherent in Work of the character shown and specified, ODR and A/E shall be notified in writing of such conditions before they are disturbed. Upon such notice, or upon its own observation of such conditions, A/E, with the approval of ODR, will promptly make such changes in the Drawings and Specifications as they deem necessary to conform to the different conditions, and any increase or decrease in the cost of the Work, or in the time within which the Work is to be completed, resulting from such changes will be adjusted by Change Order, subject to the prior approval of ODR.

11.6 Extension of Time. All changes to the Contract Time shall be made as a consequence of requests as required under Section 9.6, and as documented by Change Order as provided under Section 11.1.

11.7 Administration of Change Order Requests. All changes in the Contract shall be administered in accordance with procedures approved by Owner, and when required, make use of such electronic information management system(s) as Owner may employ.

11.7.1 Routine changes in the construction Contract shall be formally initiated by A/E by means of a PCO form detailing requirements of the proposed change for pricing by Contractor. This action may be preceded by communications between Contractor, A/E and ODR concerning the need and nature of the change, but such communications shall not constitute a basis for beginning the proposed Work by Contractor. Except for emergency conditions described below, approval of Contractor’s cost proposal by A/E and ODR will be required for authorization to proceed with the Work being changed. Owner will not be responsible for the cost of Work changed without prior approval and Contractor may be required to remove Work so installed.

11.7.2 All proposed costs for change order Work must be supported by itemized accounting of material, equipment and associated itemized installation costs in sufficient detail, following the outline and organization of the established Schedule of Values, to permit analysis by A/E
11.7.3 Any unexpected circumstance which necessitates an immediate change in order to avoid a delay in progress of the Work may be expedited by verbal communication and authorization between Contractor and Owner, with written confirmation following within twenty-four (24) hours. A limited scope not-to-exceed estimate of cost and time will be requested prior to authorizing Work to proceed. Should the estimate be impractical for any reason, ODR may authorize the use of detailed cost records of such work to establish and confirm the actual costs and time for documentation in a formal Change Order.

11.7.4 Emergency changes to save life or property may be initiated by Contractor alone (see Section 7.3) with the claimed cost and/or time of such work to be fully documented as to necessity and detail of the reported costs and/or time.

11.7.5 The method of incorporating approved Change Orders into the parameters of the accepted Schedule of Values must be coordinated and administered in a manner acceptable to ODR.

11.8 **Pricing Change Order Work.** The amounts that Contractor and/or its Subcontractor adds to a Change Order for profit and overhead will also be considered by Owner before approval is given. The amounts established hereinafter are the maximums that are acceptable to Owner.

11.8.1 For Work performed by its forces, Contractor will be allowed its actual costs paid for materials, the total amount of its actual wages paid for labor, plus its actual cost paid for State and Federal payroll taxes and for worker’s compensation and comprehensive general liability insurance, plus its actual additional bond and builders risk insurance cost if the change results in an increase in the premium paid by Contractor. To the total of the above costs, Contractor will be allowed to add a percentage as noted below to cover overhead and profit combined. Overhead shall be considered to include insurance other than mentioned above, field and office supervisors and assistants, including safety and scheduling personnel, use of small tools, incidental job burdens and general Home Office expenses, and no separate allowance will be made therefore.

Allowable percentages for overhead and profit on changes will not exceed 15 percent if the total of self-performed work is less than or equal to $10,000, 10 percent if the total of self-performed work is between $10,000 and $20,000 and 7.5 percent if the total of self-performed work is over $20,000, for any specific change priced.

11.8.2 For subcontracted Work each affected Subcontractor shall figure its costs, overhead and profit as described above for Contractor’s Work, all Subcontractor costs shall be combined, and to that total Subcontractor cost Contractor will be allowed to add a maximum mark-up of ten (10) percent if the total of all subcontracted work is less than or equal to $10,000, seven and half (7.5) percent if the total of all subcontracted work is between $10,000 and $20,000 and five (5) percent if the total of all subcontractor work is over $20,000.

11.8.3 On changes involving both additions and deletions, percentages for overhead and profit will be allowed only on the net addition. Owner does not accept and will not pay for additional Contract cost identified as indirect or consequential damages or as damages caused by delay.

11.8.4 For Contracts based on a Guaranteed Maximum Price (GMP), the Construction Manager-at-Risk or Design Builder shall NOT be entitled to a percentage mark-up on any Change Order Work unless the Change Order increases the Guaranteed Maximum Price.
11.9 **Unilateral Change Order (ULCO).** Owner may issue a written ULCO directing a change in the Work prior to reaching agreement with Contractor on the adjustment, if any, in the Contract price and/or the Contract Time.

11.9.1 Owner and Contractor shall negotiate for appropriate adjustments, as applicable, to the Contract Sum or the Contract Time arising out of a ULCO. As the changed Work is performed, Contractor shall submit its costs for such Work with its Application for Payment beginning with the next Application for Payment within thirty (30) days of the issuance of the ULCO. The Parties reserve their rights to dispute the ULCO amount, subject to Article 15.

11.10 **Finality of Changes—Contractor.** Upon execution of a Change Order and/or a ULCO by Owner, Contractor and A/E, all costs and time issues claimed by Contractor regarding that change are final and not subject to increase.

11.11 **Audit of Changes—Owner.** All Changes Orders are subject to audit by Owner or its representative at any time in accordance with Article 17.4 and Change Order amounts may be adjusted lower as a result of such audit.

### Article 12. Project Completion and Acceptance

12.1 **Closing Inspections.**

12.1.1 **Substantial Completion Inspection.** When Contractor considers the entire Work or part thereof Substantially Complete, it shall notify ODR in writing that the Work will be ready for Substantial Completion inspection on a specific date. Contractor shall include with this notice Contractor’s Punchlist to indicate that it has previously inspected all the Work associated with the request for inspection, noting items it has corrected and included all remaining work items with date scheduled for completion or correction prior to final inspection. The failure to include any items on this list does not alter the responsibility of Contractor to complete all Work in accordance with the Contract Documents. If any of the items on this list prevents the Project from being used as intended, Contractor shall not request a Substantial Completion Inspection. Owner and its representatives will review the list of items and schedule the requested inspection, or inform Contractor in writing that such an inspection is premature because the Work is not sufficiently advanced or conditions are not as represented on Contractor’s list.

12.1.1.1 Prior to the Substantial Completion inspection, Contractor shall furnish a copy of its marked-up Record Documents and a preliminary copy of each instructional manual, maintenance and operating manual, parts catalog, wiring diagrams, spare parts, specified written warranties, and like publications or parts for all installed equipment, systems, and like items as described in the Contract Documents. Delivery of these items is a prerequisite for requesting the Substantial Completion inspection.

12.1.1.2 On the date requested by Contractor, or as mutually agreed upon pending the status of the Open Items List, A/E, ODR, Contractor, and other Owner representatives as determined by Owner will jointly attend the Substantial Completion inspection, which shall be conducted by ODR or their delegate. If ODR concurs with the determination of Contractor and A/E that the Work is Substantially Complete, ODR will issue a Certificate of Substantial Completion to be signed by A/E, Owner, and Contractor establishing the date of Substantial Completion and identifying responsibilities for security, insurance and maintenance. A/E will provide with this certificate a list of Punchlist items (the pre-final Punchlist) for completion prior to final inspection. This list may include items in addition to those on Contractor’s Punchlist, which the inspection team deems necessary to correct or complete prior to final inspection. If Owner
occupies the Project upon determination of Substantial Completion, Contractor shall complete all corrective Work at the convenience of Owner, without disruption to Owner’s use of the Project for its intended purposes.

12.1.2 Final Inspection. Contractor shall complete the list of items identified on the pre-final Punchlist prior to requesting a final inspection. Unless otherwise specified, or otherwise agreed in writing by the parties as documented on the Certificate of Substantial Completion, Contractor shall complete and/or correct all Work within thirty (30) days of the Substantial Completion date. Upon completion of the pre-final Punchlist work, Contractor shall give written notice to ODR and A/E that the Work will be ready for final inspection on a specific date. Contractor shall accompany this notice with a copy of the updated pre-final Punchlist indicating resolution of all items. On the date specified or as soon thereafter as is practicable, ODR, A/E and Contractor will inspect the Work. A/E will submit to Contractor a final Punchlist of open items that the inspection team requires corrected or completed before final acceptance of the Work.

12.1.2.1 Correct or complete all items on the final Punchlist before requesting Final Payment. Unless otherwise agreed to in writing by the parties, complete this work within seven (7) days of receiving the final Punchlist. Upon completion of the final Punchlist, notify A/E and ODR in writing stating the disposition of each final Punchlist item. A/E, Owner, and Contractor shall promptly inspect the completed items. When the final Punchlist is complete, and the Contract is fully satisfied according to the Contract Documents ODR will issue a certificate establishing the date of Final Completion. Completion of all Work is a condition precedent to Contractor’s right to receive Final Payment.

12.1.3 Annotation. Any Certificate issued under this Article may be annotated to indicate that it is not applicable to specified portions of the Work, or that it is subject to any limitation as determined by Owner.

12.1.4 Purpose of Inspection. Inspection is for determining the completion of the Work, and does not relieve Contractor of its overall responsibility for completing the Work in a good and competent fashion, in compliance with the Contract. Work accepted with incomplete Punchlist items or failure of Owner or other parties to identify Work that does not comply with the Contract Documents or is defective in operation or workmanship does not constitute a waiver of Owner’s rights under the Contract or relieve Contractor of its responsibility for performance or warranties.

12.1.5 Additional Inspections.

12.1.5.1 If Owner’s inspection team determines that the Work is not substantially complete at the Substantial Completion inspection, ODR or A/E will give Contractor written notice listing cause(s) of the rejection. Contractor will set a time for completion of incomplete or defective work acceptable to ODR. Contractor shall complete or correct all work so designated prior to requesting a second Substantial Completion inspection.

12.1.5.2 If Owner’s inspection team determines that the Work is not complete at the final inspection, ODR or A/E will give Contractor written notice listing the cause(s) of the rejection. Contractor will set a time for completion of incomplete or defective work acceptable to ODR. Contractor shall complete or correct all Work so designated prior to again requesting a final inspection.

12.1.5.3 The Contract contemplates three (3) comprehensive inspections: the Substantial Completion inspection, the Final Completion inspection, and the inspection of completed final Punchlist items. The cost to Owner of additional inspections
resulting from the Work not being ready for one or more of these inspections is the responsibility of Contractor. Owner may issue a ULCO deducting these costs from Final Payment. Upon Contractor’s written request, Owner will furnish documentation of any costs so deducted. Work added to the Contract by Change Order after Substantial Completion inspection is not corrective Work for purposes of determining timely completion, or assessing the cost of additional inspections.

12.1.6 Phased Completion. The Contract may provide, or Project conditions may warrant, as determined by ODR, that designated elements or parts of the Work be completed in phases. Where phased completion is required or specifically agreed to by the parties, the provisions of the Contract related to closing inspections, occupancy, and acceptance apply independently to each designated element or part of the Work. For all other purposes, unless otherwise agreed by the parties in writing, Substantial Completion of the Work as a whole is the date on which the last element or part of the Work completed receives a Substantial Completion certificate. Final Completion of the Work as a whole is the date on which the last element or part of the Work completed receives a Final Completion certificate or notice.

12.2 Owner’s Right of Occupancy. Owner may occupy or use all or any portion of the Work following Substantial Completion, or at any earlier stage of completion. Should Owner wish to use or occupy the Work, or part thereof, prior to Substantial Completion, ODR will notify Contractor in writing and identify responsibilities for security. All Work performed by Contractor after occupancy, whether in part or in whole, shall be at the convenience of Owner so as to not disrupt Owner’s use of, or access to occupied areas of the Project.

12.3 Acceptance and Payment

12.3.1 Request for Final Payment. Following the certified completion of all work, including all final Punchlist items, cleanup, and the delivery of record documents, Contractor shall submit a certified Application for Final Payment and include all sums held as retainage and forward to A/E and ODR for review and approval.

12.3.2 Final Payment Documentation. Contractor shall submit, prior to or with the Application for Final Payment, final copies of all Close-Out documents, maintenance and operating instructions, guarantees and warranties, certificates, Record Documents and all other items required by the Contract. Contractor shall submit evidence of return of access keys and cards, evidence of delivery to Owner of attic stock, spare parts, and other specified materials. Contractor shall submit consent of surety to Final Payment form and an affidavit that all payrolls, bills for materials and equipment, subcontracted work and other indebtedness connected with the Work, except as specifically noted, are paid, will be paid, after payment from Owner or otherwise satisfied within the period of time required by Tex. Gov’t Code, Chapter 2251. Contractor shall furnish documentation establishing payment or satisfaction of all such obligations, such as receipts, releases and waivers of claims and liens arising out of the Contract. Contractor may not subsequently submit a claim on behalf of Subcontractor or vendor unless Contractor’s affidavit notes that claim as an exception.

12.3.3 Architect/Engineer Approval. A/E will review a submitted Application for Final Payment promptly but in no event later than ten (10) days after its receipt. Prior to the expiration of this deadline, A/E will either: 1) return the Application for Final Payment to Contractor with corrections for action and resubmission; or 2) accept it, note their approval, and send to Owner.

12.3.4 Offsets and Deductions. Owner may deduct from the Final Payment all sums due from Contractor. If the Certificate of Final Completion notes any Work remaining, incomplete, or defects not remedied, Owner may deduct the cost of remedying such deficiencies from the
Final Payment. On such deductions, Owner will identify each deduction, the amount, and the explanation of the deduction on or by the twenty-first (21st) day after Owner’s receipt of an approved Application for Final Payment. Such offsets and deductions shall be incorporated via a final Change Order, including a ULCO as may be applicable.

12.3.5 Final Payment Due. Final Payment is due and payable by Owner, subject to all allowable offsets and deductions, on the thirtieth (30th) day following Owner's approval of the Application for Payment. If Contractor disputes any amount deducted by Owner, Contractor shall give notice of the dispute on or before the thirtieth (30th) day following receipt of Final Payment. Failure to do so will bar any subsequent claim for payment of amounts deducted.

12.3.6 Effect of Final Payment. Final Payment constitutes a waiver of all claims by Owner, relating to the condition of the Work except those arising from:

12.3.6.1 Faulty or defective Work appearing after Substantial Completion (latent defects);
12.3.6.2 Failure of the Work to comply with the requirements of the Contract Documents;
12.3.6.3 Terms of any warranties required by the Contract, or implied by law; or
12.3.6.4 Claims arising from personal injury or property damage to third parties.

12.3.7 Waiver of Claims. Final payment constitutes a waiver of all claims and liens by Contractor except those specifically identified in writing and submitted to ODR prior to the application for Final Payment.

12.3.8 Effect on Warranty. Regardless of approval and issuance of Final Payment, the Contract is not deemed fully performed by Contractor and closed until the expiration of all warranty periods.

Article 13. Warranty and Guarantee

13.1 Contractor’s General Warranty and Guarantee. Contractor warrants to Owner that all Work is executed in accordance with the Contract, complete in all parts and in accordance with approved practices and customs, and of the required finish and workmanship. Contractor further warrants that unless otherwise specified, all materials and equipment incorporated in the Work under the Contract are new. Owner may, at its option, agree in writing to waive any failure of the Work to conform to the Contract, and to accept a reduction in the Contract price for the cost of repair or diminution in value of the Work by reason of such defect. Absent such a written agreement, Contractor’s obligation to perform and complete the Work in accordance with the Contract Documents is absolute and is not waived by any inspection or observation by Owner, A/E or others, by making any progress payment or final payment, by the use or occupancy of the Work or any portion thereof by Owner, at any time, or by any repair or correction of such defect made by Owner.

13.3 Limits on Warranty. Contractor’s warranty and guarantee hereunder excludes defects or damage caused by:

13.3.1 Modification or improper maintenance or operation by persons other than Contractor, Subcontractors, or any other individual or entity for whom Contractor is not responsible, unless Owner is compelled to undertake maintenance or operation due to the neglect of
13.3.2 Normal wear and tear under normal usage after acceptance of the Work by Owner.

13.4 **Events Not Affecting Warranty.** Contractor’s obligation to perform and complete the Work in a good and workmanlike manner in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or relieve the Contractor from its obligation to perform the Work in accordance with the Contract Documents:

13.4.1 Observations by Owner and/or A/E;
13.4.2 Recommendation to pay any progress or final payment by A/E;
13.4.3 The issuance of a certificate of Substantial Completion or any payment by Owner to Contractor under the Contract Documents;
13.4.4 Use or occupancy of the Work or any part thereof by Owner;
13.4.5 Any acceptance by Owner or any failure to do so;
13.4.6 Any review of a Shop Drawing or sample submittal; or
13.4.7 Any inspection, test or approval by others.

13.5 **Separate Warranties.** If a particular piece of equipment or component of the Work for which the Contract requires a separate warranty is placed in continuous service before Substantial Completion, the warranty period for that equipment or component will not begin until Substantial Completion, regardless of any warranty agreements in place between suppliers and/or Subcontractors and Contractor. ODR will certify the date of service commencement in the Substantial Completion certificate.

13.5.1 In addition to Contractor’s warranty and duty to repair, Contractor expressly assumes all warranty obligations required under the Contract for specific building components, systems and equipment.

13.5.2 Contractor may satisfy any such obligation by obtaining and assigning to Owner a complying warranty from a manufacturer, supplier, or Subcontractor. Where an assigned warranty is tendered and accepted by Owner which does not fully comply with the requirements of the Contract, Contractor remains liable to Owner on all elements of the required warranty not provided by the assigned warranty.

13.6 **Correction of Defects.** Upon receipt of written notice from Owner, or any agent of Owner designated as responsible for management of the warranty period, of the discovery of a defect, Contractor shall promptly remedy the defect(s), and provide written notice to Owner and designated agent indicating action taken. In case of emergency where delay would cause serious risk of loss or damage to Owner, or if Contractor fails to remedy within thirty (30) days, or within another period agreed to in writing, Owner may correct the defect and be reimbursed the cost of remediing the defect from Contractor or its surety.

**Article 14. Suspension and Termination**

14.1 **Suspension of Work for Cause.** Owner may, at any time without prior notice, suspend all or any part of the Work if, after reasonable observation and/or investigation, Owner determines it is necessary to do so to prevent or correct any condition of the Work which constitutes an immediate safety hazard or which may reasonably be expected to impair the integrity, usefulness or longevity of the Work when
completed.

14.1.1 Owner will give Contractor a written notice of suspension for cause, setting forth the reason for the suspension and identifying the Work suspended. Upon receipt of such notice, Contractor shall immediately stop the Work so identified. As soon as practicable following the issuance of such a notice, Owner will initiate and complete a further investigation of the circumstances giving rise to the suspension, and issue a written determination of the findings.

14.1.2 If it is confirmed that the cause was within the control of Contractor, Contractor will not be entitled to an extension of time for delay resulting from the suspension. If the cause is determined not to have been within the control of Contractor, and the suspension has prevented Contractor from completing the Work within the Contract Time, the suspension is an excusable delay and a time extension will be granted through a Change Order.

14.1.3 Suspension of Work under this provision will be no longer than is reasonably necessary to remedy the conditions giving rise to the suspension.

14.2 Suspension of Work for Owner’s Convenience. Upon seven (7) days written notice to Contractor, Owner may at any time without breach of the Contract suspend all or any portion of the Work for a period of up to sixty (60) days for its own convenience. Owner will give Contractor a written notice of suspension for convenience, which sets forth the number of suspension days for which the Work, or any portion of it, and the date on which the suspension of Work will cease. When such a suspension prevents Contractor from completing the Work within the Contract Time, it is an excusable delay. A notice of suspension for convenience may be modified by Owner at any time on seven (7) days written notice to Contractor. If Owner suspends the Work for its convenience for more than sixty (60) consecutive days, Contractor may elect to terminate the Contract pursuant to the provisions of the Contract.

14.3 Termination by Owner for Cause.

14.3.1 Upon thirty (30) days written notice to Contractor and its surety, Owner may, without prejudice to any right or remedy, terminate the Contract and take possession of the Site and of all materials, equipment, tools, construction equipment, and machinery thereon owned by Contractor under any of the following circumstances:

14.3.1.1 Persistent or repeated failure or refusal, except during complete or partial suspensions of work authorized under the Contract, to supply enough properly skilled workmen or proper materials;

14.3.1.2 Persistent disregard of laws, ordinances, rules, regulations or orders of any public authority having jurisdiction, including ODR;

14.3.1.3 Persistent failure to prosecute the Work in accordance with the Contract, and to ensure its completion within the time, or any approved extension thereof, specified in the Contract;

14.3.1.4 Failure to remedy defective work condemned by ODR;

14.3.1.5 Failure to pay Subcontractors, laborers, and material suppliers pursuant to Tex. Gov’t Code, Chapter 2251;

14.3.1.6 Persistent endangerment to the safety of labor or of the Work;

14.3.1.7 Failure to supply or maintain statutory bonds or to maintain required insurance, pursuant to the Contract;
14.3.1.8 Any material breach of the Contract; or
14.3.1.9 Contractor’s insolvency, bankruptcy, or demonstrated financial inability to perform the Work.

14.3.2 Failure by Owner to exercise the right to terminate in any instance is not a waiver of the right to do so in any other instance.

14.3.3 Upon receipt of a termination notice, the Contractor or its Surety has thirty (30) days to cure the reasons for the termination or demonstrate to the satisfaction of the Owner that it is prepared to remedy the condition(s) upon which the notice of termination was based with diligence and promptness. If the Owner is satisfied that the Contractor or its Surety can remedy the reasons for the termination and complete the Work as required, the notice of termination shall be rescinded in writing by the Owner and the Work shall continue without an extension of time.

14.3.4 If at the conclusion of the thirty (30) day cure period the Contractor or its Surety is unable to demonstrate to the satisfaction of the Owner its ability to remedy the reasons for termination, the Owner may immediately terminate the employment of the Contractor, make alternative arrangements for completion of the Work and deduct the cost of completion from the unpaid Contract Sum.

14.3.4.1 Owners cost to complete the Work includes, but is not limited to, fees for additional services by A/E and other consultants, and additional contract administration costs.

14.3.4.2 Owner will make no further payment to Contractor or its surety unless the costs to complete the Work are less than the Contract balance, then the difference shall be paid to Contractor or its surety. If such costs exceed the unpaid balance, Contractor or its surety will pay the difference to Owner.

14.3.4.3 This obligation for payment survives the termination of the Contract.

14.3.4.4 Owner reserves the right in termination for cause to take assignment of all the Contracts between Contractor and its Subcontractors, vendors, and suppliers. ODR will promptly notify Contractor of the contracts Owner elects to assume. Upon receipt of such notice, Contractor shall promptly take all steps necessary to effect such assignment.

14.4 Conversion to Termination for Convenience. In the event that any termination of Contractor for cause under Section 14.3 is later determined to have been improper, the termination shall automatically convert to a termination for convenience under Section 14.5 and Contractor’s recovery for termination shall be strictly limited to the payments allowable under Section 14.5.

14.5 Termination for Convenience of Owner. Owner reserves the right, without breach, to terminate the Contract prior to, or during the performance of the Work, for any reason. Upon such an occurrence, the following shall apply:

14.5.1 Owner will notify Contractor and A/E in writing specifying the reason for and the effective date of the Contract termination. The notice may also contain instructions necessary for the protection, storage or decommissioning of incomplete work or systems, and for safety.

14.5.2 Upon receipt of the notice of termination, Contractor shall immediately proceed with the following obligations, regardless of any dispute in determining or adjusting any amounts due at that point in the Contract:
14.5.2.1 Stop all work.

14.5.2.2 Place no further subcontracts or orders for materials or services.

14.5.2.3 Terminate all subcontracts for convenience.

14.5.2.4 Cancel all materials and equipment orders as applicable.

14.5.2.5 Take appropriate action that is necessary to protect and preserve all property related to the Contract which is in the possession of Contractor.

14.5.3 When the Contract is terminated for Owner’s convenience, Contractor may recover from Owner payment for all Work executed. Contractor may not claim lost profits or lost business opportunities.

14.6 Termination By Contractor. If the Work is stopped for a period of ninety (90) 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 Subcontractor or their agents or employees or any other persons performing any of the Work under a contract with Contractor, then Contractor may, upon thirty (30) additional days written notice to ODR, terminate the Contract and recover from Owner payment for all Work executed, but not lost profits or lost business opportunities. If the cause of the Work stoppage is removed prior to the end of the thirty (30) day notice period, Contractor may not terminate the Contract.

14.7 Settlement on Termination. When the Contract is terminated for any reason, at any time prior to one hundred eighty (180) days after the effective date of termination, Contractor shall submit a final termination settlement proposal to Owner based upon recoverable costs as provided under the Contract. If Contractor fails to submit the proposal within the time allowed, Owner may unilaterally determine the amount due to Contractor because of the termination and pay the determined amount to Contractor.

Article 15. Dispute Resolution

15.1 Unresolved Contractor Disputes. To the extent that it is applicable, the dispute resolution process provided for in Tex. Gov’t Code, Chapter 2260, shall be used by Contractor to resolve any claim for breach of Contract made by Contractor that is not resolved under procedures described in these Uniform General Conditions or Owner’s Special Conditions of the Contract.

15.2 Alternative Dispute Resolution Process. Owner may establish a dispute resolution process to be utilized in advance of that outlined in Tex. Gov’t Code, Chapter 2260.

15.3 Nothing herein shall hinder, prevent, or be construed as a waiver of Owner’s right to seek redress on any disputed matter in a court of competent jurisdiction.

15.4 In any litigation between the Owner and the Contractor arising from this Contract or this Project, neither party will be entitled to an award of legal fees or costs in any judgment regardless which one is deemed the prevailing party.

15.5 Nothing herein shall waive or be construed as a waiver of the State’s sovereign immunity.

Article 16. Certification of No Asbestos Containing Material or Work

16.1 Contractor shall insure that Texas Department of State Health Services licensed individuals, consultants or companies are used for any required asbestos work including asbestos inspection, asbestos abatement plans/specifications, asbestos abatement, asbestos project management and third-party asbestos monitoring.
16.2 Contractor shall provide a notarized certification to Owner that all equipment and materials used in fulfillment of its Contract responsibilities are non-Asbestos Containing Building Materials (ACBM). This certification must be provided no later than Contractor's application for Final Payment.

16.3 The Contractor shall insure compliance with the following acts from all of his subcontractors and assigns:

- Asbestos Hazard Emergency Response Act (AHERA—40 CFR 763-99 (7));
- Texas Asbestos Health Protection Rules (TAHPR—Tex. Admin. Code Title 25, Part 1, Ch. 295C, Asbestos Health Protection

**Article 17 Miscellaneous**

17.1 **Owner’s Special Conditions.** When the Work contemplated by Owner is of such a character that the foregoing Uniform General Conditions of the Contract cannot adequately cover necessary and additional contractual relationships, the Contract may include Owner’s Special Conditions that relate to the Project. In the event of a conflict between the UTUGCs and the Owner’s Special Conditions, the Owner’s Special Conditions will govern.

17.2 **Federally Funded Projects.** On Federally funded projects, Owner may waive, suspend or modify any Article in these Uniform General Conditions which conflicts with any Federal statute, rule, regulation or procedure, where such waiver, suspension or modification is essential to receipt by Owner of such Federal funds for the Project. In the case of any Project wholly financed by Federal funds, any standards required by the enabling Federal statute, or any Federal rules, regulations or procedures adopted pursuant thereto, shall be controlling.

17.3 **Internet-based Project Management Systems.** At its option, Owner may administer its design and construction management through an Internet-based management system. In such cases, Contractor shall conduct communication through this media and perform all Project related functions utilizing this database system. This includes correspondence, submittals, Requests for Information, vouchers or payment requests and processing, amendment, Change Orders and other administrative activities.

17.3.1 **Accessibility and Administration.**

17.3.1.1 When used, Owner will make the software accessible via the Internet to all Project team members.

17.3.1.2 Owner shall administer the software.

17.3.2 **Training.** When used, Owner shall provide training to the Project team members.

17.4 **Right to Audit.**

17.4.1 Contractor understands that acceptance of funds under this Contract acts as acceptance of the authority of the State Auditor’s Office, Owner, any successor agency and their representatives, including independent auditors, to conduct an audit or investigation in connection with those funds. Contractor further agrees to cooperate fully with any party conducting the audit or investigation, including providing all records requested.

17.4.2 Contractor shall maintain and retain supporting fiscal and any other documents relevant to showing that any payments under this Contract funds were expended in accordance with the terms of this Contract, the requirements of Owner, and with the laws and regulations of the State of Texas including, but not limited to, requirements of the Comptroller of the State of Texas.
Texas and the State Auditor. Contractor shall maintain all such documents and other records relating to this Contract and Owner’s property for a period of four (4) years after the date of submission of a request for Final Payment or until a resolution of all billing questions, whichever is later. Contractor shall make available at reasonable times and upon reasonable notice and for reasonable periods all documents and other information related to the Work of this Contract.

17.4.3 Contractor shall ensure that this clause concerning the authority to audit funds received indirectly by subcontractors through the Contractor and the requirement to cooperate is included in any subcontract it awards.

17.5 179 D Benefit Allocation. Owner may decide to seek the allocation of certain tax benefits pursuant to Section 179D of the Internal Revenue Code of 1986, as amended, (the “Code”) through its Agreement with Contractor.

If the Owner and the Internal Revenue Service (IRS) determine that the Contractor is eligible to receive the 179D deduction allocation as a “Designer” for the purposes of Section 179D of the Code or that Contractor could otherwise profit financially from the monetization of the benefit (separately and collectively, the “Rebate”), Contractor hereby agrees to allocate to the Owner a portion of the Rebate in an amount to be determined and contracted for on mutually agreeable terms when the value of the Rebate becomes ascertainable, net of associated costs realized by the Owner and Project Architect. At its sole discretion, the Owner shall determine whether to receive its portion of the Rebate in cash, discounted Contractor fees or both.

Owner reserves the right to retain a third party consultant (the “Consultant”) to manage and administer the process of obtaining and monetizing the Rebate derived from the Project(s).

Contractor agrees to cooperate in all reasonable respects with the Consultant’s efforts to obtain and monetize any such Rebates derived from the Project(s) on behalf of the Owner. Certification of eligibility and negotiation of the Rebates should be facilitated by the Owner’s 179D Consultant.

End of Uniform General Conditions
SECTION 01 45 00 - PROJECT QUALITY CONTROL

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

1.1.1. Drawings and general provisions of the Contract, including Uniform General and Supplementary General Conditions for University of Texas System Building Construction Contracts (UGC) and other Division 1 – Division 33 Specification Sections, apply to this Section. In the event of conflict between specific requirements of the various documents, the more restrictive, more extensive (i.e., more expensive) requirement shall govern.

1.2. DEFINITIONS

1.2.1. QUALITY CONTROL

1.2.1.1. Quality Control shall be the sole responsibility of the Contractor, unless specifically noted otherwise. The Contractor shall be responsible for all testing, coordination, start-up, operational checkout and commissioning of all items of work included in the project, unless specifically noted otherwise. All costs for these services shall be included in the Contractor’s cost of work and general conditions.

1.2.1.2. The Contractor shall assign one employee, not the project superintendent, to be responsible for Quality Control. This individual can have other responsibilities, but shall not be the project superintendent or the project manager.

1.2.2. QUALITY ASSURANCE

1.2.2.1. Quality Assurance is performed by the Owner or their delegated representatives. These procedures may include observations, inspections, testing, verification, monitoring and any other procedures deemed necessary to ensure compliance with the contract documents.

1.2.2.2. The Contractor shall cooperate with and provide assistance to the Owner for all aspects of this endeavor. This shall include providing ladders, lifts, scaffolds, lighting, protection, safety equipment and any other devices and/or equipment (including operators if required) deemed necessary by the Owner to access the work for observation/inspection.

1.3. SUMMARY

1.3.1. This section provides administrative and procedural requirements for Contractor quality control on the project.

1.3.2. Specific quality-control requirements for individual construction activities are specified in the Sections that govern those activities. Requirements in those Sections may also cover production of manufactured products.
1.3.3. Specified tests, inspections, and related actions do not limit Contractor's quality control obligations to comply fully with the Contract Document requirements in all regards.

1.3.4. Provisions of this Section do not limit the requirements for the Contractor to provide quality control services required by the contract documents or the Authority Having Jurisdiction.

1.3.5. The following quality issues are addressed in detail in this Section:

   1.3.5.1. Quality Control
   1.3.5.2. Quality Assurance
   1.3.5.3. Testing Agency
   1.3.5.4. Testing
   1.3.5.5. Inspections
   1.3.5.6. Pre-installation Meetings
   1.3.5.7. Mock-ups

1.4. TESTING AGENCY

   1.4.1. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

   1.4.2. Owner will employ services of independent testing agencies to perform certain specified testing, as it deems necessary.

   1.4.3. The Contractor shall employ and pay for services of an independent testing agency to perform all specified testing requiring an independent agency, unless noted otherwise.

   1.4.4. Employment of agency in no way relieves the Contractor of the obligation to perform Work in accordance with requirements of Contract Documents.

   1.4.5. The Contractor Employed Agency:


       1.4.5.2. Laboratory shall maintain a full time Engineer on staff to review services. Engineer shall be licensed in the state of Texas.

       1.4.5.3. Testing Equipment: Calibrate devices at reasonable intervals (minimum yearly) with accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.
1.4.6. The Contractor shall not employ the same testing entity engaged by the Owner for the project, unless agreed to in writing by the Owner.

1.5. TESTING

1.5.1. Where specific testing is specified in a technical section of the Specifications or indicated in the Contract Documents, the Contractor shall bear all costs of such tests unless they are specifically stated to be paid by the Owner.

1.5.2. Testing specifically identified to be conducted by Owner will be performed by an independent entity and will be arranged and paid for by the Owner unless otherwise indicated in the Contract Documents. Should the test return unacceptable results, the Contractor shall bear all costs of retesting and reinspection as well as the cost of all material consumed by testing, and replacement of unsatisfactory material and/or workmanship.

1.5.3. The Owner’s Construction Inspector (CI) will schedule the Owner’s testing services unless otherwise directed in writing by the Owner. The Contractor is required to coordinate with the CI to facilitate timeliness of such testing services.

1.5.4. The Owner may engage additional consultants for testing, air balancing, or other special services. The activities of any such Owner consultants are in addition to Contractor testing of materials or systems necessary to prove that performance is in compliance with requirements. The Contractor must cooperate with persons and firms engaged in these activities in accordance with the Contract.

1.5.4.1. The Contractor is required to self-perform various tests to verify performance and/or operation of various systems. These test reports shall be consecutively numbered and defined by scope and extent of test. Copies of the test report forms can be obtained from the RCM. The following OFPC test report forms shall be used for this purpose and shall not be altered in any manner:

1.5.4.1.1. Pipe Test Report
1.5.4.1.2. Duct Test Report
1.5.4.1.3. Equipment Start-up Request Form
1.5.4.1.4. Contractor’s Request for Utility Shutdown
1.5.4.1.5. Domestic Water Sterilization and Flushing Report

1.6. INSPECTIONS

1.6.1. It is the intent of the Contract Documents that all work be subjected to inspection and verification of correct operation prior to 100% payment of the line item(s) pertaining to that aspect of the Work.

1.6.2. The Contractor shall incorporate adequate time for performance of all inspections and correction of noted deficiencies into the Work Progress Schedule for the project.
1.6.3. During the course of construction, the Owner, Architect and/or other Owner representatives may visit the site for observation of the work in place. The Contractor shall provide all necessary equipment for safe access to the work to be inspected or observed. This requirement shall extend to all Owner personnel and their representatives. Some of these inspections will be informal and some will require formal notification by the Contractor. The following are typical project inspections:

1.6.3.1. Informal Daily Reviews of project conditions by the Construction Inspector and/or members of the Owner's and/or Design Consultant’s team(s). When considered appropriate, results of these reviews will be documented via Observation Report or Memorandum. In addition to cooperating with, and providing safe access for the Owner's agents, the Contractor shall provide a system of tracking all field reports, describing items noted and resolution of each item. This printed report shall be reviewed as necessary, at least on a monthly basis.

1.6.3.2. Concealed Space Inspections are to be formally scheduled in advance through the Construction Inspector by submitting written notification at least five (5) workdays in advance. Subject areas include partitions, structural walls, chases, crawl spaces, ceiling spaces, and any other work which will be difficult or impossible to examine once concealed in the final construction.

1.6.3.3. Progress Inspections for piping, ductwork, and other systems are to be scheduled with the Construction Inspector as appropriate portions, or sections, of the work are completed. This is in addition to "system-wide" performance verification and tests. These tests are to be scheduled and documented using the standard OFPC Pipe Test and Duct Test report forms. The forms shall be filled out and signed as meeting contract requirements prior to submission for verification by the OFPC CI. The Contractor shall conduct the tests and the OFPC CI will witness and approve the results.

1.6.3.3.1. The Contractor shall coordinate their intended "apportioning" of systems tests with the Construction Inspector immediately following formal submission of their Work Project Schedule so that all parties are aware of the intended work and inspection sequence.

1.6.3.4. Overhead and Above Ceiling Inspections are similar in nature and requirements to the Concealed Space Inspections. Where ceilings are to be fixed in place, such as gypsum board or plaster, it would constitute a Concealed Space. Where ceilings are of "lay-in" type, or where no finish ceiling is scheduled, it would be considered an "overhead" inspection. Such inspections are to be included in the Contractor's Detailed Construction Schedule. Contractor shall provide written inspection request notice to the CI and Architect at least five (5) workdays in advance.

1.6.3.4.1. No finish ceiling material shall be installed until all overhead punchlist items have been resolved to the satisfaction of the Owner.

1.6.3.4.2. Work in place necessary for an overhead inspection shall include:
1.6.3.4.2.1. Ceiling grid or framework installed

1.6.3.4.2.2. All above ceiling electrical work, including light fixtures, installed and operational

1.6.3.4.2.3. All HVAC and plumbing work above ceiling complete with diffusers installed and connected

1.6.3.4.2.4. Fire sprinkler heads installed

1.6.3.4.2.5. All required tests for above ceiling work completed and approved

1.6.3.4.2.6. Contractor generated punchlist of all areas being requested for inspection

1.6.3.5. Inspections of Building Systems and Equipment are required to confirm acceptable operation and are to be formally scheduled through the Construction Inspector with the Architect. Refer to Section 01 91 00 for additional requirements pertaining to system start-up, operation, demonstration and acceptance.

1.6.4. On systems/equipment requiring a manufacturers representative to verify installation/operation, the Contractor is required to perform a thorough check-out of operations with the manufacturer's representatives prior to requesting formal inspection by the Owner be scheduled. Notify the CI, in advance, as to when the manufacturer’s representative is scheduled to arrive.

1.6.5. Inspection of individual equipment and/or system(s) must be accomplished prior to requesting Substantial Completion Inspection for any area affected by that equipment and/or system.

1.6.6. For "building-wide" and/or life safety systems, such as fire alarm, fire sprinkler systems, smoke evacuation systems, toxic gas monitoring, captured exhaust systems, etc., completion and acceptance of Functional Testing is required prior to requesting Substantial Completion Inspection for any area of the Project.

1.6.6.1. The manufacturer's representatives and the installing contractor will be expected to demonstrate both operation and compliance to the Owner's agents and consultants. If coordinated and scheduled appropriately by the Contractor, these equipment and/or systems inspections may also serve to provide the required Owner Training, if approved in advance by the Owner.

1.6.6.2. The Contractor is responsible for requesting that the Construction Inspector and Architect arrange for the inspection of materials, equipment and work prior to assembly or enclosure that would make the materials, equipment or work inaccessible for inspection, and at such other times as may be required.

1.6.7. For any requested inspection, the Contractor shall make prior inspection to ensure that items are ready for inspection and acceptance by the Owner and/or Architect.
The Contractor will be responsible for any and all costs incurred by Owner and/or Owner representatives, including consultants, resulting from a review or inspection that was scheduled prematurely.

1.6.8. The Contractor shall coordinate the work and schedule the inspections in advance so as not to delay the work. All major inspections should be indicated on the Work Progress Schedule for advance planning and the Contractor should allow a minimum of five (5) working days to confirm schedule of requested inspections with Owner and its consultants.

1.6.9. The contractor shall list and track all punchlist items on the OFPC Project Inspection Matrix (refer to Attachment A). The matrix shall be kept up-to-date reflecting status of work in place and inspections on the project. Copies of this populated and updated matrix shall be supplied to the A/E and the OFPC CI for use during the course of the project.

1.7. PRE-INSTALLATION MEETINGS

1.7.1. The Contractor shall coordinate and conduct meetings to review the installation of major systems/equipment on the project.

1.7.2. The Contractor shall ensure attendance of the installing subcontractor, manufacturer and/or supplier (if appropriate), supporting subcontractors involved in the installation and any other parties involved in the phase of work to be reviewed. The Owner and Architect shall be notified in writing at least five (5) days in advance of the meeting.

1.7.3. Each party shall be prepared to discuss in detail the staging, installation procedure, quality control, testing/inspection, safety and any other pertinent items relating to the work being reviewed. Submittal approval shall be a prerequisite of the meeting.

1.7.4. The Contractor shall chair and take minutes of this meeting and distribute to all attending parties.

1.7.5. Whether required in the technical section or not, a pre-installation meeting shall be conducted for the following work, if included in the project:

1.7.5.1. Concrete
1.7.5.2. Masonry
1.7.5.3. Large Steel Fabrications/Erection
1.7.5.4. Waterproofing
1.7.5.5. Roofing
1.7.5.6. Exterior Glazing (including storefront and curtain wall)
1.7.5.7. Door Hardware
1.7.5.8. Security

1.7.5.9. Audio/Visual Equipment

1.7.5.10. Air Handling Units

1.7.5.11. Medical Gas Systems

1.8. MOCK-UPS

1.8.1. Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required, using materials indicated for the completed Work.

1.8.2. Build mockups in location and of size indicated or, if not indicated, as directed by Architect. The mock-up may be work in place that is intended to remain, unless otherwise directed by the Owner.

1.8.3. Notify Architect and Owner five (5) working days in advance of dates and times when mockups will be constructed.

1.8.4. Demonstrate the proposed range of aesthetic effects and workmanship. Include anticipated repairs in mockup, such as stone veneer.

1.8.5. Obtain Architect's and Owner’s approval of mockups before starting work, fabrication, or construction.

1.8.6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

1.8.7. Demolish and remove mockups when directed, unless otherwise indicated.

1.8.8. For any of the following work items included in the project, a mockup shall be prepared whether required by the technical section or not:

1.8.8.1. Exterior wall system to include: substructure, masonry/stone veneer, plaster, architectural concrete and windows.

1.8.8.2. Roof system

1.8.8.3. Interior lab room

1.8.8.4. Interior patient care room

1.8.8.5. Interior wall finishes

1.8.8.6. Ceramic tile

1.8.8.7. Finished flooring
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 45 00
SECTION 01 77 00 - PROJECT CLOSE-OUT PROCEDURES

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

1.1.1. Provisions established within the Uniform General and Supplementary General Conditions for University of Texas System Building Construction Contracts (UGC), all Sections of Division 1 - General Requirements, other applicable Sections of all Divisions of Specifications, and the Drawings are collectively applicable to this Section. In the event of conflict between specific requirements of the various documents, the more restrictive, the more extensive (i.e.. more expensive) requirement shall govern.

1.2. SECTION OVERVIEW

1.2.1. General Description of Closeout Requirements

1.2.2. Requirements for Substantial Completion

1.2.3. Provisions for Release of Retainage

1.2.4. Requirements for Final Acceptance

1.2.5. Required Project Record Documents

1.2.6. Project Cleaning

1.3. GENERAL DESCRIPTION OF CLOSEOUT REQUIREMENTS

1.3.1. DEFINITION: Project Closeout is hereby defined to include requirements near the end of the Contract Time, in preparation for substantial completion acceptance, occupancy by Owner, release of retainage, final acceptance, final payment, and similar actions evidencing completion of the work. Specific additional requirements for individual units of work are specified in Sections of Divisions 2 - 33.

1.3.2. TIME of closeout is directly related to completion and acceptance, and therefore may be either a single time period for the entire project, or a series of time periods for individual portions or phases of the project that have been certified as substantially complete at different dates.

1.3.3. This Section is based on completion and acceptance of the entire project during a single time period.

1.3.3.1. If the project is to be accepted in phases, whether by originally specified project scope or by subsequent agreement between the parties, then Project Closeout requirements shall pertain to each separately accepted portion or phase of the project; unless by written notice the Owner allows for these requirements to be done singularly upon anticipated acceptance of the final phase.
1.3.4. RECORD DOCUMENTS for Project Closeout include, but are not necessarily limited to the following drafts, which are required at substantial completion:

1.3.4.1. As-Built Record Drawings
1.3.4.2. As-Built Record Specifications
1.3.4.3. Operating & Maintenance Manuals
1.3.4.4. Record Approved Submittals and Samples
1.3.4.5. Certification of No Asbestos Products Incorporated in Project
1.3.4.6. Completed Punch Lists

1.3.5. REQUIRED DOCUMENTS for final payment to be released include final versions of all of the above and the following:

1.3.5.1. Final Release of Claims & Liens
1.3.5.2. Affidavit of payment of Debt and Claims
1.3.5.3. Consent(s) of Surety
1.3.5.4. Completed SWPPP documents and Notice Of Termination
1.3.5.5. Final Historically Underutilized Business Plan
1.3.5.6. Completed Commissioning and Closeout Manual

1.4. REQUIREMENTS FOR SUBSTANTIAL COMPLETION

1.4.1. Prior to requesting Architect and Owner to schedule a Substantial Completion, or Pre-Final, inspection (for either the entire work or portions thereof as agreed to by the parties to the contract); complete the following and list known exceptions in request.

1.4.1.1. In progress payment request coincident with period of time anticipated for substantial completion, Contractor's payment request should reflect a minimum of 95% completion for all applicable work.
1.4.1.2. Submit to Architect and Owner a complete copy of the Contractor's most current punch list covering the portion(s) of the Project claimed as substantially complete.

1.4.1.2.1. Such punch list shall indicate dates of Contractor re-checks and schedule for completion of work items remaining.
1.4.1.2.2. All items remaining outstanding on the Contractor's punch list shall include a projected date of completion and/or correction with an explanation of why such is not presently completed.
1.4.1.3. Submit to Architect for review the full set of as-built marked-up record drawings and marked-up record specifications as described later in this Section.

1.4.1.4. Submit to Architect for review the preliminary copies of Owner's Operating and Maintenance (O&M) Manuals as described later in this Section.

1.4.1.5. Provide access to Contractor’s copy of the Commissioning and Closeout Manual for review by Owner and Architect. The Manual shall be up to date before the Substantial Completion inspection can be requested.

1.4.1.6. Submit certification statement that no asbestos containing materials have been used or incorporated into the project.

1.4.1.7. Obtain and submit releases enabling Owner's full and unrestricted use of the work and access to services and utilities, including (where applicable) operating certificates, and similar releases.

1.4.1.8. Deliver tools, spare parts, extra stocks of materials, and similar physical items to Owner.

1.4.2. If Owner intends to occupy Project upon Substantial Completion Acceptance, Contractor shall make provisions for final changeover of locks with the Owner's personnel. Upon written directive from Owner, this task may be waived until final acceptance for the convenience of the Contractor in completing punch list activity.

1.4.3. Complete instructions of Owner's personnel for all systems and equipment serving the areas claimed as substantially complete, for which Owner Training was not completed in association with system demonstrations and inspections. Refer also to Section 01 91 00 - Project Commissioning.

1.4.4. Complete initial clean up requirements as described later in this Section for the entire portion of the Project claimed as substantially complete. Touch up and otherwise repair and restore marred exposed finishes.

1.4.5. SUBSTANTIAL COMPLETION INSPECTION PROCEDURE

1.4.5.1. Refer to UGC and Section 01 45 00 - Project Quality Control

1.4.5.1.1. The Contractor shall ensure the work is ready for inspection and/or reinspection. If the work is found not to be as stated in the Contractor’s punchlist or the items have not been substantially corrected/completed; the inspection will be terminated all costs for the Owner and A/E team for scheduling and attendance at the terminated inspection(s) shall be the responsibility of the Contractor.

1.5. PROVISIONS FOR RELEASE OF RETAINAGE

1.5.1. Refer to UGC
1.5.2. Release of any retainage, or reduction in amount of retainage withheld, is strictly at the discretion of the Owner, regardless of Contractor compliance with requirements. All of the requirements noted for Substantial Completion Acceptance must be completed prior to application for final release of contract retainage. In addition, meet the following requirements:

1.5.2.1. Submit affidavits of final release of claim and lien from each subcontractor and supplier who provided materials and/or labor to the Project.

1.5.2.2. Submit affidavit that all bills for the Project have been paid, or will be paid within thirty (30) days of Contractor receipt of payment.

1.5.2.3. Submit Consent of Surety to Release of Retainage.

1.6. REQUIREMENTS FOR FINAL ACCEPTANCE

1.6.1. Prior to requesting Architect and Owner to schedule Final Inspection for the Project, complete the following:

1.6.1.1. Prepare draft payment request showing 100% completion for each line item on the Schedule of Values. Submit with this draft all final releases and supporting documentation not previously submitted and accepted. Include Certificates of Insurance where applicable. Note that Final Payment, including final release of retainage, will not be issued until all work (including punch list items) has been completed, all requirements met, a project closeout audit performed (if deemed necessary) and a Final Change Order has been processed if required to resolve final cost or closeout audit issues, including deletion of any remaining contract allowances.

1.6.1.2. Submit copy of Architect/Engineer's pre-final, or substantial completion, punch list, which includes evidence that each item has been completed or otherwise resolved.

1.6.1.3. Submit final meter readings for utilities, and similar data as of time of substantial completion or when Owner took possession of and responsibility for corresponding elements of the work.

1.6.1.4. Submit final record as-built drawings and specifications, copies of all approved submittals, and operating & maintenance manuals as described later in this Section. This includes specific warranties, maintenance agreements, product certifications and similar documents. Record closeout documentation must be acceptable to Architect and Owner prior to issuance of final payment.

1.6.1.5. Transmit completed Commissioning and Closeout Manual to the Owner. This manual shall be complete, acknowledging receipt of all attic stock, spare parts, training/demonstration, test reports and any other requirements of the contract documents.

1.6.1.6. Complete final cleaning requirements, including touch-up of marred surfaces.
1.6.1.7. Submit final payment request, including the following documentation:

1.6.1.7.1. Consent of Surety
1.6.1.7.2. Release of Liens and Claims
1.6.1.7.3. Affidavit of payment of Debts and Claims
1.6.1.7.4. Final Historically Underutilized Business Plan
1.6.1.7.5. Completed and signed Notice Of Termination

1.6.1.8. Revise and submit evidence of final and continuing insurance coverage complying with applicable insurance requirements.

1.6.2. FINAL ACCEPTANCE INSPECTION PROCEDURE

1.6.2.1. Upon compliance with all above noted requirements, and following completion of the work required in the substantial completion punch list, provide written notice to the Architect and Owner that the project is ready for Final Inspection. Refer to UGC for additional requirements.

1.6.2.2. All Owner and Architect costs for travel and man-hours for additional inspections at either Substantial Completion or Final Acceptance which are required either by failure of the Contractor to complete the noted punch list items, or by erroneous notices that the work is ready for such inspections, will be the responsibility of the Contractor. Such costs will be deleted from the contract amount in Change Order.

1.7. REQUIRED PROJECT RECORD DOCUMENTS

[U. T. Austin projects require three (3) copies of project record documents where two (2) are indicated under this section.]

1.7.1. AS-BUILT RECORD DRAWINGS

1.7.1.1. Do not use record documents for construction purposes; protect from deterioration and loss in a secure location; provide access to record documents for Owner and/or Architect's reference or review during normal working hours.

1.7.1.2. In general terms; the Contractor is to furnish one set of 4 mil Mylar prints made from the Architect's contract drawings, or subsequent updates thereof, annotated as noted below with actual as-built conditions, two sets of prints made from the mylars, and the original marked-up prints.

1.7.1.2.1. As-built information is to be professionally drafted on first-generation contract prints from which the mylars are to be made.

1.7.1.2.2. As-builts are required to show all changes in the work relative to the original contract documents; and show additional information of
value to Owner's records, but not indicated in original contract documents.

1.7.1.3. Record as-builts are to include marked-up copies of contract drawings and specifications, including newly-prepared drawings if any such are applicable or necessary to achieve the intended result, and shop drawings to include all changed conditions issued through addenda and/or change orders.

1.7.1.3.1. Include marked up product data submittals, field records for variable and concealed conditions such as excavations and foundations, and further; miscellaneous record information on work, which is otherwise recorded only schematically or not at all.

1.7.1.4. Certain individual sections of Divisions 2 through 33 indicate specific requirements, which may clarify requirements of this section. Where a conflict may be perceived to exist, the more restrictive (i.e., more expensive) requirement will prevail. There is no intent, however, to require more sets of as-builts than is indicated herein.

1.7.1.5. The Contractor shall bear all costs associated with obtaining the Architect's original contract documents, or subsequent updated plots thereof, drafting of as-built information, reproduction, including mylar drawings, or other related work.

1.7.1.5.1. All "as built" changes shall be of good drafting quality, performed by a person skilled in drafting and knowledgeable of the conventions of the trades involved.

1.7.1.5.2. The Contractor may utilize his staff or seek outside assistance, including the Project Architect, for this drafting work so long as the requirements pertaining to quality, format, and content are met.

1.7.1.6. MAINTENANCE OF AS-BUILT DRAWINGS DURING CONSTRUCTION

1.7.1.6.1. During progress of the work, maintain a printed set of contract drawings along with specifications and shop drawings in the construction office. Update these drawings weekly, at a minimum, with markup of actual installations, which vary from the work as originally shown.

1.7.1.6.1.1. Mark whatever drawing is most capable of showing actual physical condition, fully and accurately, and reference all other appearances of this work to the sheet, which was updated. Include cross-reference to the official change number on the updated sheet and all additional sheets where the work is shown.
1.7.1.6.1.2. Mark with erasable colored pencil, using separate colors where feasible to distinguish between changes for different categories of work at same general location.

1.7.1.6.1.3. Mark up important additional information, which was either shown schematically or omitted from original drawings. Give particular attention to information on work concealed, which would be difficult to identify or measure and record at a later date.

1.7.1.6.1.4. Note alternative numbers, change order numbers and similar identification for any change.

1.7.1.6.1.5. Require each person preparing markup to initial and date markup and indicate name of firm.

1.7.1.6.2. The Contractor shall maintain and have available for review in conjunction with the regular project meetings, a current set of the as-built drawings and specifications marked with "as constructed" information. Availability for review, and acceptability, of both the format and the content is a prerequisite condition for certification of monthly pay requests by the Owner and Architect.

1.7.2. SUPPLEMENTAL DRAWINGS

1.7.2.1. Where marked-up shop drawings are intended for inclusion in the record set, mark cross-reference on contract drawings at corresponding location. Use of shop drawings as supplements to the record as-builts is encouraged for all items which require the larger scale employed on the shop drawings in order to show the work in sufficient detail to be of future use to the Owner.

1.7.2.1.1. Use of such shop drawings is particularly applicable to ductwork and electrical shop drawing layouts. Use of shop drawing supplements is acceptable so long as the following conditions are met:

1.7.2.1.1.1. Regardless of overall size of the original shop drawings, such will be reproduced photographically onto mylar sheets of the same size with equivalent borders and titles as the contract drawings and other record as-built drawings. Include project name and number as well as the applicable submittal number.

1.7.2.1.1.2. The applicable supplemental sheet shall be placed in the set directly behind the contract drawing, which it supplements, with appropriate reference notes on both the applicable contract drawing and all other affected drawings.
1.7.2.1.3. The supplemental document shall be identified as a "Supplementary Record As-Built Drawing" and shall be numbered with an extension to the contract drawing it supplements in a manner acceptable to the Owner.

1.7.3. PREPARATION OF FINAL AS BUILT DRAWINGS

1.7.3.1. This Section requires that a copy of the marked-up as-builts be submitted to the Architect for review prior to requesting substantial completion inspections.

1.7.3.1.1. Following the Architect's review of the marked-up prints, and upon authorization by the Architect based on their belief that the marked-up information is accurate and complete, the Contractor shall proceed with preparation of a full set of professionally drafted record drawings.

1.7.3.2. All record as-built drawings and supplemental shop drawing sheets must be reproduced on 4-mil thick mylar film. This includes the entire set of contract drawings, whether or not individual sheets are affected by as-built data. Mylars shall be made from the first-generation prints of the contract drawings; mylars or sepias made from marked up prints will not be accepted under any circumstances.

1.7.3.3. All drawings shall bear the official project name and number. Further, each drawing, including supplemental drawings, shall also bear a stamp to the effect of "Record As-Built" along with the Contractor's certification that such is an accurate reflection of actual as-built conditions. Each certification shall be signed and dated and shall be acceptable to the Owner.

1.7.3.3.1. All drawings shall be the same size as original contract documents.

1.7.3.3.2. All "as built" notes and drafting on mylars should be made with ink for use on mylars (no pencil lead or colored pencil).

1.7.3.3.3. The marked-up prints shall be turned over to the Architect along with the final mylar documents for review and acceptance. Once such final mylar documents are acceptable to the Architect as complying with this section and other contract requirements. They will transmit final mylars to the Owner along with the marked-up prints and all other close-out documentation.

1.7.3.3.4. All drawings issued as addenda, clarifications and/or change orders shall be incorporated into the record as-built drawing set. Such shall be fully shown on the applicable contract drawing. If supplemental sheets are used, follow the requirements outlined above for supplemental shop drawing sheets.
1.7.4. AS-BUILT RECORD SPECIFICATIONS

1.7.4.1. During progress of the work, maintain and update one record copy of specifications at the jobsite, including addenda, change orders and similar modifications issued in printed form during construction, to indicate all significant variations in actual work in comparison with text of specifications as originally issued.

1.7.4.1.1. Give particular attention to substitutions, selection of options, and similar information on work where the exact products used are not clearly identified or readily discernable in the original specifications. Note related record drawing information and product data, where applicable.

1.7.4.1.2. It is not necessary to re-type an entire section if modified, but it is mandatory that all changes to specified materials, installation, warranty, etc. be clearly and fully marked within the applicable specifications section in a manner acceptable to the Architect and the Owner. Such should be reviewed and a documentation procedure established early in the construction period.

1.7.4.2. In association with request for substantial completion inspection, submit the marked-up copy of the Project Specifications to the Architect for review.

1.7.4.3. Once the marked-up Project Specifications are found acceptable by the Architect, and upon his authorization, based on his belief that the marked-up information is accurate and complete; proceed with preparation of a Record Set Project Specifications.

1.7.4.3.1. Neatly transcribe and post all as-built mark-up information to a "clean" copy of the Project Specifications, insuring that similar types of information is annotated in like fashion throughout the Specifications.

1.7.4.4. Once completed, submit both the mark-up site copy of the Project Specifications and the newly prepared Record Project Specifications to the Architect for review and, if acceptable, for subsequent transmittal to the Owner.

1.7.5. OPERATING AND MAINTENANCE MANUALS

1.7.5.1. In general terms, the Contractor is to organize maintenance-and-operating manual information into suitable sets of manageable size, and bind into individual binders properly tabbed and indexed.

1.7.5.1.1. Such shall include emergency instructions, spare parts listings, warranties, wiring diagrams, inspection procedures, shop drawings, product data, and similar applicable information.
1.7.5.1.2. Such shall be bound in heavy-duty, 3-ring vinyl-covered binders including pocket folders for folded sheet information. Mark binder identification on both front and spine of each binder.

1.7.5.1.3. Two complete copies of each bound O&M Manual are required.

1.7.5.2. The requirements of this Section are separate, distinct and in addition to product submittal requirements that may be established by other Sections of the Specifications. Owner's manuals, manufacturer's printed instructions, parts lists, and other submittals required by other Sections of the Specifications may be included in the O&M Manuals provided that they are approved and are formatted in a manner consistent with the requirements of this Section.

1.7.5.2.1. Test data and Commissioning data included in the O&M Manuals need not be duplicated in the Commissioning and Closeout Manual. Test data not pertaining to a particular device or piece of equipment (such as domestic water pipe pressure test reports) shall be inserted in the C&C Manual.

1.7.5.3. Equipment is defined as any mechanism, mechanical, electrical or electronic device, or any combination thereof, which is made up of two or more working parts to perform a particular function.

1.7.5.4. When an item of equipment is a packaged unit furnished by one manufacturer and the package as furnished contains proprietary items of equipment obtained from other sources; copies of equipment data as required herein shall be furnished for each item of such equipment as if it had been separately furnished.

1.7.5.5. For general guidance only, the following are examples of equipment, material, and systems for which operating and maintenance data is required:

<table>
<thead>
<tr>
<th>Pipe &amp; Fittings</th>
<th>Air Handling Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate Valve</td>
<td>Temperature Controls</td>
</tr>
<tr>
<td>Elevators</td>
<td>Pumps and Controllers</td>
</tr>
<tr>
<td>Electrical Switchgear</td>
<td>Irrigation System</td>
</tr>
<tr>
<td>Light Fixtures</td>
<td>Fire Sprinkler</td>
</tr>
<tr>
<td>Transformers</td>
<td>Security Systems</td>
</tr>
<tr>
<td>Electric Panel</td>
<td>Wall Light Switches</td>
</tr>
<tr>
<td>Circuit Breakers</td>
<td>Motors &amp; Devices</td>
</tr>
<tr>
<td>Metal Fabrications</td>
<td>Telephone Systems</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>Fume Hoods</td>
</tr>
<tr>
<td>A/C Diffusers</td>
<td>Fire Alarm System</td>
</tr>
<tr>
<td>Sterilizers</td>
<td>Compressors</td>
</tr>
<tr>
<td>Laboratory Casework</td>
<td>Overhead Coiling Doors</td>
</tr>
<tr>
<td>Finish Hardware</td>
<td>Access Flooring</td>
</tr>
<tr>
<td>Automatic Door Operators</td>
<td>Finish Materials</td>
</tr>
</tbody>
</table>
1.7.5.6. All the applicable data for any one item of equipment or material or system shall be bound together as a package, within a Manual containing like equipment, materials, or systems, as indicated by the appropriate specification division. Each package of data shall be numbered according to the Specification Section governing the particular system.

1.7.5.7. All data furnished in accordance with this Section shall be submitted on bindable 8-1/2" x 11" sheets or on sheets that are bindable and foldable multiples of 8-1/2" x 11". The bindable edge shall be the left 11" edge.

1.7.5.8. Waivers to the size requirement may be requested in specific instances upon application in writing to the Architect and Owner with justification for substitution in size.

1.7.5.9. Material and equipment data required by this Section is intended to include all data necessary for the proper installation, removal, normal operation, emergency operation, startup, shutdown, maintenance, cleaning, adjustment, calibration, lubrication, assembly, disassembly, repair, inspection, trouble shooting and service of the equipment or materials.

1.7.5.10. The UGC requires that a preliminary copy of all operating and maintenance manuals, in addition to as-built documents, be furnished prior to the Substantial Completion inspection. The Contractor is to accumulate and package the documentation, and submit it to the Architect for review.

1.7.5.11. The Contractor's submission of a preliminary copy of all O&M Manuals to the Architect for review is a precondition for scheduling of a Substantial Completion Inspection. The Contractor's final submission of these Manuals in an acceptable format (based on review of preliminary copies by the Architect) is a precondition for scheduling of a Final Acceptance Inspection, release of remaining contract retainage, or application for Final Payment.

1.7.5.12. Equipment Data to be Included in O&M Manuals

1.7.5.12.1. Description of Equipment shall be prepared upon 8-1/2" x 11" forms. Include one such form for each item of equipment. Refer also to the equipment list requirements of Sections 01 91 00 - Project Commissioning, 23 00 00 - General Mechanical and 26 00 00 - General Electrical. The equipment information to be included in the O&M Manuals is as follows:

1.7.5.12.1.1. Complete description of item: Such should list basic descriptive terminology first, followed by modifying words to include model, size and weight, flow rate, amperage, voltage, material, etc., as applicable, plan designation, if any, and package serial number

1.7.5.12.1.2. Part Number: Manufacturer's and supplier's part number.
1.7.5.12.1.3. Quantity: Total quantity of this equipment item installed under this Contract.

1.7.5.12.1.4. Specification Paragraph Reference: State the specification section and paragraph under which the item of equipment was procured, and page number.

1.7.5.12.1.5. Source: Manufacturer's name and address and supplier's name and address.

1.7.5.12.1.6. Serial Number: Complete manufacturer's serial number(s) or other identity symbol(s) as applicable.

1.7.5.12.1.7. Location: State the name of the system and/or sub-system in which each like item of equipment is installed and state the physical location of each like item of equipment by identifying the columnar grid intersections, as shown on the plans, near which the item is located and also state the room or space title as applicable.

1.7.5.12.2. Parts Lists which clearly identifies every part in the item of equipment with the proper manufacturer's name, part nomenclature and number, local source, and list price.

1.7.5.12.3. Recommended Spare Parts. Furnish a list of recommended spare parts for each equipment item that will be needed to support that item of equipment for a 12-month period. The quantities of spare parts recommended shall be based upon the quantity of like equipment items installed under the Contract. The recommended spare parts list for each equipment item shall be prepared upon 8-1/2" x 11" forms which contain the following information for each part in columns:

1.7.5.12.3.1. Part Description: Complete descriptive nomenclature plus manufacturer's complete model and part number, and list price cost for each part.

1.7.5.12.3.2. Quantity Per Assembly: Quantity of listed part that occurs in the item of equipment.

1.7.5.12.3.3. Quantity of Equipment Items: Quantity of like equipment items installed under this Contract.

1.7.5.12.3.4. Shelf Life: Storage life of part, in months, if the part has limited life.

1.7.5.12.3.5. Recommended Quantity: Quantity of part recommended to support the installed quantity of equipment in which the part appears for a period of 12 months.
1.7.5.12.3.6. Source for part: Name, address, and phone number of the nearest supplier for the part.

1.7.5.12.4. Contractor's Purchase Order: Copy of Contractor's purchase order for equipment. The copy furnished need only show quantity ordered, part number, equipment description and name and address of vendor who supplied the item.

1.7.5.12.5. Normal Operating Instructions: Normal operating instructions shall provide sufficient detailed information to permit a journeyman mechanic to adjust, startup, operate and shut down the equipment. Special startup precautions must be noted as well as other action items required before the equipment is put into service.

1.7.5.12.6. Emergency Operating Procedures: A detailed description of the sequence of action to be taken in the event of a malfunction of the unit, either to permit a short period of continued operation or emergency shutdown to prevent further damage to the unit and to the system in which it is installed.

1.7.5.12.7. Preventive Maintenance: Detailed information to cover routine and special inspection requirements, including field adjustments, inspections for wear, adjustment changes, packing wear, lubrication points, frequency and specific lubrication type required, cleaning of the unit and type solvent to use, and such other measures as are applicable to preventive maintenance program.

1.7.5.12.8. Calibration: Detailed data on what to calibrate, how to calibrate, when to calibrate and procedures to enable checking the equipment for reliability or indications as well as data for test equipment, special tools and the location of test points.

1.7.5.12.9. Scale and Corrosion Control: Detailed information covering the prevention of and removal of scale and corrosion.

1.7.5.12.10. Troubleshooting Procedures: Detailed information and procedures for detecting and isolating malfunctions and detailed information concerning probable causes and applicable remedies.

1.7.5.12.11. Removal and Installation Instructions: Detailed information concerning the logical sequence of steps required to remove and install the item including instructions for the use of special tools and equipment.

1.7.5.12.12. Disassembly and Assembly Instructions: Detailed illustrations and text to show the logical procedure and provide the
instructions necessary to disassemble and assemble the unit properly. The text shall include all checks and special precautions as well as the use of special tools and equipment required to perform the assembly or disassembly.

1.7.5.12.13. **Repair Instructions**: Detailed repair procedures to bring the equipment up to the required operating standard including instruction for examining equipment and parts for needed repairs and adjustments, and tests or inspections required to determine whether old parts may be reused or must be replaced.

1.7.5.12.14. **System Drawings**: Detailed drawings, where applicable, that clearly show wiring diagrams, control diagrams, system schematics, pneumatic and fluid flow diagrams, etc., which pertain to the unit function. Drawings are required to show modifications to another manufacturer's standard unit which is incorporated into the assembly or package unit.

1.7.5.12.14.1. System diagrams shall be provided on multiples of 8-1/2" x 11" format, folded to fit within the Manual. The outer (exposed) face of the folded drawing shall include identification of the system and the specification section that governs its installation and operation.

1.7.5.12.14.2. The requirements of this paragraph are separate, distinct, and in addition to similar requirements that may be established by other Sections. Where such system diagrams are required for submittal by other specification sections, the same diagrams will be acceptable for inclusion herein, so long as the diagrams used were approved during the submittal phase and they are reproduced for clarity and to fit the size format of the O&M Manual.

1.7.5.12.14.3. The Contractor shall provide diagrammatic drawings for each installed system, which shall show the placement of the system in relation to the building, and the physical location of each item or equipment installed within the system. Each installed item of equipment shown on the drawing will be identified by the equipment item model and/or serial/part number.

1.7.5.12.14.4. System drawings may, for purpose of clarity, be prepared upon a major subsystem basis.

1.7.5.12.14.5. The drawings may be prepared upon several drawings having referenced match lines.
1.7.5.12.15. **Special Tools and Test Equipment**: Furnish a detailed list of the special tools and test equipment needed to perform repair and maintenance for each equipment item. The list shall contain the special tool and test equipment part number, size, quantity, price, manufacturer's name and address, and local supplier's name and address.

1.7.5.12.16. **Warranties & Guarantees**: Bind within the tabbed section for each system, equipment item, or material, an executed copy of the specified warranty/guarantee covering that particular system, equipment item, or material.

1.7.5.12.16.1. This is to include both the manufacturer's warranty as specified and the installing contractor's guarantee for workmanship and system operation.

1.7.5.12.16.2. This copy of the particular warranty/guarantee is in addition to original signature copies of all project warranties/guarantees bound together separately. This binder shall be transmitted to the Owner when complete.

1.7.5.12.16.3. Provide in a separate tabbed section of the O&M Manual a grouping of all project warranties and guarantees as required by various specification sections and other conditions of the Contract. This is to include all specific warranties on manufactured items and installed systems as noted above, in addition to General Contractor's project warranty and applicable guarantees from all subcontractors and suppliers covering defects in workmanship or manufacture.

1.7.5.12.16.4. As clarification, it is intended that the Owner be provided with a separate binder containing all original project warranties and guarantees. Also provide a copy of the appropriate warranty in the same section as the equipment (or system) data furnished in individual tabbed sections of the O&M Manuals for convenient reference.

1.7.5.12.17. **Training of Owner Personnel**: Documentation of training of Owner's Personnel regarding operation of particular systems shall be included within the tabbed section for that particular system. Such documentation shall include identification of parties receiving training and date(s) of such training.

1.7.6. **MISCELLANEOUS RECORD INFORMATION**

1.7.6.1. The following shall be bound in like manner to above noted equipment data and system drawings. It is suggested that a separate tabbed section be included in the Commissioning and Closeout Manual for these
Miscellaneous Items. Categories of requirements resulting in miscellaneous work records are recognized to include, but not limited, the following:

1.7.6.1.1. Required field records on excavations, foundations, underground construction, wells and similar work.

1.7.6.1.2. Accurate survey showing locations and elevations of underground lines, including invert elevations of drainage piping.

1.7.6.1.3. Surveys establishing lines and levels of building.

1.7.6.1.4. Plant treatment records (wood, soil, etc)

1.7.6.1.5. Certifications received in lieu of labels on products and similar record documentation.

1.7.6.1.6. Batch mixing and bulk delivery records.

1.7.6.1.7. Testing and qualification of tradesmen.

1.7.6.1.8. Documented qualification of installation firms.

1.7.6.1.9. Load/performance testing.

1.7.6.1.10. Final inspection and deficiency corrections.

1.7.7. RECORD PRODUCT SUBMITTALS

1.7.7.1. During progress of the work, maintain approved copies of each product data submittal and shop drawing, and mark up significant variations in the actual work in comparison with submitted information. Include both variations in product as delivered to site, and variations from manufacturer's instructions and recommendations for installation.

1.7.7.1.1. A separate binder with one copy off all MSDS sheets for any and all products incorporated into the project shall be maintained during the course of the project. This binder shall be included in the record submittal documents.

1.7.7.2. Give particular attention to concealed products and portions of the work that are not clearly identified in the original submittal or cannot otherwise be readily discerned at a later date by direct observation. Cross reference to change orders and markup of record drawings and specifications.

1.7.7.3. Upon completion of as-built revisions, submit two complete sets of all approved submittals to Architect for review and subsequent transmittal to Owner. Organize and group files in sturdy file boxes with tabbed dividers for each separate specification division. Include a complete table of contents.
1.7.7.4. These record submittal requirements are in addition to inclusion of similar material as supplementary as-built drawings or technical data for the O&M Manuals.

1.7.8. RECORD SAMPLE SUBMITTAL

1.7.8.1. Immediately prior to date(s) of substantial completion, arrange for Architect and Owner's representative to meet with Contractor at site to determine which (if any) of the submitted samples or mock-ups maintained by Contractor during progress of the work are to be transmitted to Owner for record purposes.

1.7.8.2. Comply with Architect's instructions for packaging, identification marking, and delivery to Owner's designated location at the Project Site or the Physical Plant.

1.7.8.3. Dispose of other samples in manner specified for disposal of surplus and waste materials, unless otherwise indicated or directed by Architect.

1.7.9. COMMISSIONING AND CLOSEOUT MANUAL (C&C Manual)

1.7.9.1. The Contractor shall incorporate all commissioning and closeout documentation and/or verification not included in the O&M manuals, into a Manual for transmittal to the Owner at the conclusion of the project. This Manual is intended to be a consolidation of documentation/verification for the project Commissioning and Closeout process.

1.7.10. Requirements for production of this manual are found in Section 01 91 00 Project Commissioning.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1. PROJECT CLEANING AT SUBSTANTIAL COMPLETION

3.1.1. The Contractor is required to maintain the project and site in a clean and orderly condition throughout the course of construction. In addition to continuous project cleaning, the following requirements are related to project closeout.

3.1.2. Special cleaning for specific units of work may also be specified in other sections of Project Specifications.

3.1.3. Provide an initial cleaning of the work consisting of cleaning each surface or unit of work to normal "clean" condition expected for a first-class building cleaning and maintenance program.

3.1.4. Comply with manufacturer's instructions for cleaning of all system components, equipment, and materials incorporated into the Project.
3.1.5. The following "initial" final cleaning is to be accomplished immediately prior to the time the Contractor requests Substantial Completion Inspection:

3.1.5.1. Remove labels that are not required as permanent labels.

3.1.5.2. Clean exposed hard-surfaced finishes, including glass, metals, stone, concrete, painted surfaces, plastics, tile, wood, special coatings, and similar surfaces, to a dirt-free condition, free of dust, stains, films and similar noticeable distracting substances. Restore reflective surfaces to original condition.

3.1.5.3. Remove debris and surface dust from limited-access spaces including plenums, shafts, and similar spaces.

3.1.5.4. Clean concrete floors in non-occupied spaces, wet-mop and broom clean.

3.1.5.5. Clean fixtures and lamps of all dust and debris.

3.1.5.6. Remove crates, cartons and other flammable waste materials or trash from work areas. Building(s) shall be turned over to the Owner free of concealed garbage, trash and rodent infestation. If any of the preceding are revealed, or odors from them occur, they shall be removed by the Contractor at his expense. Restore property to its original condition where no improvements are shown.

3.1.5.7. Elevator shafts, electrical closets, pipe and duct shafts, chases, furred spaces, and similar spaces which are generally unfurnished, shall be cleaned and left free from rubbish, loose plaster, mortar drippings, extraneous construction materials, dirt and dust.

3.1.5.8. Rubbish shall be lowered by way of chutes, taken down on hoists, or lowered in receptacles. Under no circumstances shall any rubbish or waste be dropped or thrown from one level to another within or outside the building(s).

3.1.5.9. Care shall be taken by workmen not to mark, soil or otherwise deface finished surfaces. In the event that finished surfaces become defaced, all costs for cleaning and restoring such surfaces to their originally intended condition shall be the responsibility of the Contractor.

3.2. PROJECT CLEANING AT FINAL ACCEPTANCE

3.2.1. The following "final" cleaning is to be accomplished immediately prior to the time the Contractor requests Final Acceptance Inspection:

3.2.1.1. Clean transparent materials, including mirrors and window/door glass, to a polished condition, removing substances that are noticeable as vision-obscuring materials.

3.2.1.2. Turn the work over in immaculate condition inside and outside including the premises.
3.2.1.3. Clean all work on the premises including walks, drives, curbs, paving, fences, grounds and walls. Slick surfaces shall be left with a clear shine. Cleanup shall include removal of smudges, marks, stains, fingerprints, soil, dirt, paint, dust, lint, labels, discolorations and other foreign materials.

3.2.1.4. Clean all finished surfaces on interior and exterior of project (again) including floors, walls, ceilings, windows, glass, doors, fixtures, hardware and equipment. Final wax and polish all natural finish metal on interior or exterior surfaces. Clean and apply finish (including wax) to all floors as recommended by the manufacturer.

3.2.1.5. In addition to the cleaning specified above and the more specific cleaning required in various Sections of the Specifications, the building(s) shall be prepared for occupancy by a thorough cleaning throughout, including washing (or cleaning by approved methods) surfaces on which dirt or dust has collected, and by washing glass on both sides. Wash exterior glass using a window-cleaning contractor specializing in such work.

3.2.1.6. Remove temporary buildings and structures, fences, scaffolding, surplus materials and rubbish of every kind from the site of the work. Repair these areas to be compatible with the surrounding construction finished condition.

END OF SECTION 01 77 00
SECTION 23 00 00 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Mechanical Requirements specifically applicable to Division 23 sections, in addition to Division 01 - General Requirements.

1.2 RELATED DOCUMENTS

A. Basic and supplemental requirements common to HVAC.

B. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the specifications apply to the work specified in this section.

C. All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.3 GENERAL

A. The Contractor shall execute all work herein after specified or indicated on accompanying drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the drawings

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation

C. The Mechanical drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, above suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Or where no ceilings exist. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted. All work shall be NFPA compliant and compliant with Insurance Underwriter requirements and guidelines.

D. When the Mechanical drawings do not give exact details as to the elevation of pipe and ductwork, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping is generally intended to be installed true and square to the building construction, The drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas, unless there is no ceiling.

1.4 DEFINITIONS

A. These definitions are included to clarify the direction and intention of these Specifications. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner’s representative.
1. Concealed / Exposed: Concealed areas are those that cannot be seen by the building occupants. Exposed areas are all areas that are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

2. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements that are included in project. Basic contract definitions are included in the General Conditions.

3. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

4. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

5. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

6. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

7. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

8. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

9. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.05 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

A. General: Refer to Division 01 for construction phasing and time increments.
B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If city or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to city controlled services. If inspections by city personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.6 CONTRACT DRAWINGS

A. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the specifications, the drawings, and the schedules are as follows: The specifications determine the nature and setting of the several materials, the drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the drawings or specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.7 SUBMITTALS

A. Refer to Division 1, UGC, and supplemental UGCs for specification requirements pertaining to timeliness of submission and review, quantity, and format. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.

B. Proposed Products List: Include Products specified in the following sections:

1. Section 23 05 13 - Motors
2. Section 23 05 16 - Expansion Compensation
3. Section 23 05 29 - Sleeves, Flashings, Supports and Anchors
4. Section 23 05 48 - Vibration Isolation
5. Section 23 05 53 - Mechanical Identification
6. Section 23 05 93 – Testing, Adjusting, and Balancing
7. Section 23 05 93.A – Testing, Adjusting, and Balancing – Contractor Responsibilities

8. Section 23 06 20- Hydronic Specialties

9. Section 23 07 16 - Equipment Insulation

10. Section 23 07 19 - Piping Insulation

11. Section 23 20 00 - HVAC Pumps

12. Section 23 20 10- Piping, Valves and Fittings

13. Section 23 21 00 - Hydronic Piping

14. Section 23 29 23 – Variable Frequency Drives

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories clearly marked and/or highlighted, with non-applicable information or data clearly noted in a single submittal.

D. Mark dimensions and values in units to match those specified.

E. Submit fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

1.8 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment that will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these specifications have been met and samples shall be furnished when requested. All manufacturers’ data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.
C. It is not the intent of the drawings and/or specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the drawings and specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the specifications.

J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers’ catalogs, sales literature, or incorporated in the shop drawings.
L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.9 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.10 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.11 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA)

1. NFPA No. 45, Fire Protection for Laboratories Using Chemicals
2. NFPA No. 51, Welding & Cutting, Oxygen-Fuel Gas Systems
3. NFPA No. 54, Gas Appliances, Piping, National Fuel Gas Code
4. NFPA No. 70, National Electrical Code
5. NFPA No. 72D, Proprietary Signaling Systems
6. NFPA No. 90A, Air Conditioning Systems
7. NFPA No. 91, Blower & Exhaust Systems
8. NFPA No. 99, Health Care Facilities
10. NFPA No. 211, Chimneys, Fireplaces, Vent Systems


12. NFPA No. 255, Method of Test of Surface Burning Characteristics of Building Materials


C. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards

D. American National Standards Institute (ANSI)
   1. B31.1, Power Piping

E. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these specifications.

F. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes

G. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards

H. National Electrical Manufacturers’ Association (NEMA): All current editions of applicable manuals and standards.

I. International Mechanical Code

J. Texas Occupational Safety Act: All applicable safety standards.

K. Occupational Safety and Health Act (OSHA).

L. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

M. Refer to specification sections hereinafter bound for additional Codes and Standards.

N. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.
O. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.12 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot dip galvanized, mill galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.
1.13 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other sections. Obtain permission of [Owner] [Architect/Engineer] before proceeding.

1.14 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, testing, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer’s directions, and shall obtain the Architect/Engineer’s instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.15 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of Fire Protection equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.16 LARGE APPARATUS

A. Any large piece of apparatus that is to be installed in any space in the building, and that is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.17 PROTECTION

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.
C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

1.18  **COOPERATION BETWEEN Trades AND WITH OTHER CONTRACTORS**

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.19  **ELECTRICAL WIRING OF MOTORS AND EQUIPMENT**

A. The Contractor shall note that the electrical design and drawings are based on the equipment scheduled and indicated on the drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The electrical trades shall provide all interconnecting wiring for the installation of all power. The electrical trades shall provide all disconnect switches as required for proper operation, as indicated on the drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 26.

C. Provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the electrical trades by the Contractor.

1.20  **SUPERVISION**

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the drawings, the matter shall be referred to the A/E for ruling.

1.21  **SITE OBSERVATION**

A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.
1.22 INSTALLATION METHODS

A. Where to Conceal: All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All pipes run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping."

2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 5 working days or as agreed by the Project Manager.

3. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures shall be complete and installed in accordance with contract requirements, including power to fans, and other powered items. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager’s Construction Inspector(s), the Resident Construction Manager, and Office of Facilities Planning and Construction (OFPC). Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.
1.23 RECORDS FOR OWNER

A. The Contractor shall maintain a set of "blueline" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At contract completion, the Contractor shall provide an electronic file of the revised drawings. The contractor shall transfer the information from the "blueline" prints maintained as described above, and turn over this neatly marked set of reproducible drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these specifications, and to the Uniform General Conditions, for additional information. These drawings shall include as a minimum:

1. Addendum written drawing changes.
2. Addendum supplementary drawings.
3. Accurate, dimensioned locations of all underground utilities, services and systems.
4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
5. Change Order written drawing changes.

C. Electronic Media

1. The contractor shall submit three compact discs containing all the drawings in AUTOCAD 12 or 14 format.

D. "As installed" plans shall bear a stamp, "stick-on decal" or lettered title block generally located in lower right hand corner of drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
3. Valve tag charts and diagrams specified herein.
4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
5. Copies of approved shop drawings.
6. Any and all other data and/or drawings required as submittals during construction.
7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

F. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.24 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as new" condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Special Note: No cutting, boring, or excavating that will weaken the structure shall be undertaken.

1.25 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workers, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall them upon completion of work in the areas affected.
D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, and piping.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, coordination meetings shall be included in the contract amount.

1.26 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items that are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workers skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities that must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

1.27 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Check inspections shall include heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.
1.28 COOPERATION AND CLEANUP

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.29 CLEANING AND PAINTING

A. All equipment and piping, etc., furnished and installed in exposed areas under Division 23 of these specifications and as hereinafter specified shall be cleaned and prepared, according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 23 work.

B. All purchased equipment shall be delivered to the job with a suitable factory protective finish.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.

C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.

E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.2 NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters.
C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

D. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.

1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

D. Space Requirements:

1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

E. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations, as shown on the drawings and stated in the specifications.

C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed “tee” structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.
D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.

F. Precedence of Materials:

1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.

2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":
   a. Building lines
   b. Structural members
   c. Structural support frames supporting ceiling equipment
   d. Electric tracked vehicle system
   e. Pneumatic trash and linen system
   f. Pneumatic tube system
   g. Soil and drain piping
   h. Vent piping
   i. Supply, return and outside air ductwork
   j. Exhaust ductwork
   k. HVAC water and steam piping
   l. Condensate piping
   m. Fire protection piping
   n. Natural gas piping
   o. Medical/Laboratory gases
   p. Domestic water (cold and hot, softened, treated)
   q. Refrigerant piping
   r. Electrical conduit
3. Coordinate fire protection system with other trade systems as required to maintain system right-of-ways.

### 3.3 TESTING

A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of Substantial Completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean and properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

C. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.

D. Notify the Project Manager and the Architect/Engineer in writing at least five (5) calendar days or as agreed by the Project Manager prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.

E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results an other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

F. Maintain Log of Tests as hereinafter specified.

G. See specifications hereinafter for additional tests and requirements.

H. Refer to Commissioning Specification Sections for additional Start-up, prefunctional and operational checkout, and for functional performance test procedures.

### 3.4 PIPING PRESSURE TESTS

A. The following lines shall be tested at the stated pressure for the length of time noted:

<table>
<thead>
<tr>
<th>Testing Service</th>
<th>Testing Medium</th>
<th>Pressure (PSIG)</th>
<th>Time in Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
</tbody>
</table>
B. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled “Project Closeout Procedures.”

3.5 TRAINING

A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled “Project Closeout Procedures.”

END OF SECTION 21 00 00
SECTION 23 05 13 – MOTORS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements
B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Single phase electric motors
B. Three phase electric motors
C. The Contractor shall provide all motors required for equipment supplied under this Division of the work

1.3 RELATED WORK

A. Section 23 20 00 - HVAC Pumps

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings
B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings
C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators
D. ANSI/NEMA MG 1 - Motors and Generators
E. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00
B. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.
C. Submit manufacturer's installation instructions under provisions of Section 23 00 00

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00
B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three-years documented product development, testing, and manufacturing experience.

1.8 REGULATORY REQUIREMENTS
A. Conform to ANSI/NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Section 23 00 00.
B. Store and protect products under provisions of Section 23 00 00.
C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY
A. Provide five year manufacturer's warranty under provisions of Section 23 00 00.
B. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS
A. Open Design Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.
B. Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.
C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.
E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.
F. Motors shall be built in accordance with the latest ANSI, IEEE, and NEMA Standards, and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled, and of approved manufacture as described herein or of the same manufacture as the equipment which they serve. All motors provided by the Contractor shall be of the same manufacture unless they are an integral part of the piece of equipment to which they are attached. Nameplate rating of motors shall match the characteristics scheduled.

G. All motors shall be designed for NEMA Design B starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.

H. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

I. Dynamic Balance shall be no greater than the vibration limits of the driven equipment.

J. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

2.2 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Acceptable Manufacturers: Subject to conformance with these specifications, furnish motors by one of the following manufacturers:

1. Baldor
2. TECO/Westinghouse
3. Toshiba
4. General Electric

B. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 3-phase and shall be squirrel cage premium efficiency induction type with standard NEMA frame sizes.

C. All three phase motors shall be inverter duty rated and equipped with a shaft grounding device. Inverter duty motors shall be capable of withstanding repeated peaks of 1600 volts at 0.1 microsecond rise time and comply with NEMA MG-1 Part 31.

D. Motors 1 HP and larger shall have integral frames.

E. Starting Torque: Between one and one and one-half times full load torque.

F. Starting Current: Six times full load current.

G. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B Characteristics.

I. Insulation System: NEMA Class B or better.

J. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Test and balance motors to limits defined in 2.01J.

K. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

L. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter or VFD; refer to Division 26 for Starter Requirements. Refer to Specification Section 23 29 23 for Variable Frequency Drives.

M. Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory pre-packed with a non-detergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for L-10, 200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

N. Sound Power Levels: Refer to ANSI/NEMA MG 1.

O. Weatherproof Epoxy Treated Motors (Where Indicated): Epoxy coat windings with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

P. Nominal Efficiency: Furnish all motors with minimum efficiency equal to or greater than Efficiency Level of Premium Efficiency Motors as defined in the latest version of NEMA MG-1.

Q. Service Factor: M Furnish all motors with service factor equal to or greater than that required in the latest version of NEMA MG-1

R. Motors 1 HP and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

S. Motors 3/4 HP and larger shall have 120V space heater that is energized only when motor is idle. (Galveston only.)

**PART 3 - EXECUTION**

3.1 APPLICATION
A. Motors shall be open drip-proof type, unless specified otherwise.

END OF SECTION 23 05 13
SECTION 23 05 16 – EXPANSION COMPENSATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements
B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
C. Section 23 05 53 – Mechanical Identification
D. Section 23 20 00.A – Pipes, Valves, and Fittings

1.2 SECTION INCLUDES

A. Flexible pipe connectors
B. Expansion joints and compensators
C. Pipe loops, offsets, and swing joints

1.3 RELATED SECTIONS

A. Section 23 21 00 - Hydronic Piping

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.
B. Expansion Calculations:
   1. Installation Temperature: 50 degrees F.
   2. Chilled water: 42 degrees F.
   3. Safety Factor: 30 percent.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.
B. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
C. Samples: Submit two low pressure compensators 1 inch in size.
D. Design Data: Indicate selection calculations.
1.6 PROJECT RECORD DOCUMENTS
A. Submit under provisions of Section 23 00 00.
B. Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.7 OPERATION AND MAINTENANCE DATA
A. Submit under provisions of Section 23 00 00.
B. Maintenance Data: Include adjustment instructions.

1.8 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
B. Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.
B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY
A. Provide five-year warranty.
B. Warranty: Include coverage for leak free performance of packed expansion joints.

1.11 EXTRA MATERIALS
A. Provide two 12 ounce containers of packing lubricant and cartridge style grease gun.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS
A. Steel Piping:
   1. Manufacturers:
      a. Metraflex
      b. Flex-Weld
      c. Flexicraft
   2. Inner Hose: ASTM Grade 304, 316, or 321 Stainless Steel.
3. Exterior Sleeve: Double braided ASTM Grade 304, 316, or 321 stainless steel.

4. Pressure Rating: 150 psig WOG at 250 degrees F for circulating water systems; 125 SWP at 400 F for steam

5. Joint: As specified for pipe joints.


7. Maximum offset: 3/4 inch on each side of installed center line.

8. Application: Pump connections and vibration isolating connections on steel circulating water systems.

B. Single/Double Flexible Sphere:

1. Manufacturers:
   a. Metraflex
   b. Flex-Weld
   c. Kinetics Noise Control

2. Body: EPDM (Teflon)

3. Working Pressure: 225 psi at 170 F

4. Maximum Temperature: 225 degrees F.

5. Maximum Compression: Single sphere: 1/2 inch; double sphere: 1 3/4 inches


10. Size: Use pipe sized units.

11. Accessories: Control rods or control cables to prevent overextension


PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Construct spool pieces to exact size of flexible connection for future insertion.

C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

E. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where indicated.

G. Provide expansion loops as indicated on drawings.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Section 23 00 00.

B. Provide inspection services by flexible pipe manufacturer's representative for final installing and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 23 05 16
SECTION 23 05 48 – VIBRATION ISOLATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. 23 00 00 -- Basic Mechanical Requirements
   B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors
   C. 23 05 53 -- Mechanical Identification

1.2 WORK INCLUDED
   A. Vibration isolation
   B. Inertia bases

1.3 SCOPE OF WORK:
   A. Furnish and install all labor, materials, equipment tools and service and perform all operations
      required in connection with or properly incidental to the construction of complete system of
      vibration and noise control, as indicated on the Drawings, reasonably implied therefrom or as
      specified herein, unless specifically excluded.

1.4 REFERENCES
   A. ASHRAE - Guide to Average Noise Criteria Curves

1.5 QUALITY ASSURANCE
   A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition

1.6 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 23 00 00.
   B. Indicate inertia bases on shop drawings.
   C. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and
      described on product data.
   D. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.7 CERTIFICATES
   A. Submit a certificate from the manufacturer that isolators are properly installed and properly
      adjusted to meet or exceed specified requirements.

1.8 INTENT OF RESPONSIBILITY:
   A. It is the intent of this specification to provide for vibration isolation supports for all equipment,
      piping, and ductwork as set out below. The transmission of perceptible vibration, structural borne
      noise, or objectionable air borne noise to occupied areas by equipment installed under this
      contract will not be permitted. The Contractor shall be held responsible for installing the vibration
      isolators as specified herein or shown on the drawings or otherwise required to prevent the
transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics, effects, and criteria, and one which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Concrete housekeeping pads and inertia bases shall be included as part of mechanical work. Pads under electrical gear shall be included as part of electrical work. The concrete work shall meet the requirements specified in the General Contract Specifications.

C. The Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.

D. The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the isolation manufacturer or his qualified representative, in company with the Architect or his designated representative, shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect, or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Vibration isolation devices shall be as manufactured by Vibration Mountings & Controls Inc (VMC), Kinetics Noise Control, or approved equal.

2.2 GENERAL DESIGN FEATURES:

A. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.

B. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts, and washers shall be zinc-electroplated or cadmium plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

C. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.
D. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

E. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".

F. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

2.3 ISOLATOR TYPES: ISOLATOR TYPES AND REQUIRED DEFLECTIONS ARE SPECIFIED UNDER “SCHEDULE OF ISOLATED EQUIPMENT,” PARAGRAPH 3.2. THE ISOLATORS SHALL COMPLY WITH THE FOLLOWING DESCRIPTIONS FOR EACH TYPE REQUIRED ON THE PROJECT:

A. Type 3 - An elastomeric mounting having steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric materials. The elastomer may be Neoprene or high synthetic rubber with anti-ozone and anti-oxidant additives. Mountings shall be designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.

2.4 BASE TYPES: BASE TYPES AND REQUIRED DEFLECTIONS ARE SPECIFIED UNDER “SCHEDULE OF ISOLATED EQUIPMENT,” PARAGRAPH 3.2, OR ARE INDICATED ON THE DRAWINGS. THE BASES SHALL COMPLY WITH THE FOLLOWING DESCRIPTIONS FOR EACH TYPE REQUIRED ON THE PROJECT.

A. Type B-2 - A concrete inertia base, consisting of a perimeter steel pouring forming, reinforcing bars welded in place, bolting templates, anchor bolts, and height-saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6" deep. The inertia base for pumps shall be at least equal in weight to the pump with its driving motor and be sized for a minimum overlap of 4" around the base of the equipment. Concrete inertia bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Install vibration isolators for motor driven equipment.

B. Set steel bases for 1-inch clearance between housekeeping pad and base. Set concrete inertia bases for 2-inch clearance. Adjust equipment level.

C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

D. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, to be mounted on the scheduled vibration isolator type to prevent the
transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. After the piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. The isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length which will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load.

E. Piping:

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.

2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights, and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

4. All springs supporting piping shall be capable of an additional 1/2" deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.

F. Resilient Sleeves:

1. Resilient sleeves shall be provided at all points where equipment room walls, floors, or ceilings are penetrated by ducts, piping, or refrigerant line, etc.

3.2 SCHEDULE OF ISOLATED EQUIPMENT:

A. Tabulated below is a schedule of equipment on this project requiring vibration isolation and base isolators of the types listed above. Any equipment, system, construction or condition that may be altered, added, or changed; or that is not specifically considered herein or on the plans shall be treated in a manner that is set out for similar equipment system or construction in order to comply with the above requirements heretofore cited.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Isolator Equipment Type</th>
<th>Isolator Deflection</th>
<th>Base Isolator Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps</td>
<td>3</td>
<td></td>
<td>B-2</td>
</tr>
</tbody>
</table>

END OF SECTION 23 05 48
SECTION 23 06 20 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification
   D. Section 23 20 00.A – Piping, Valves, and Fittings

1.2 WORK INCLUDED
   A. Gauges and Gauge Connections
   B. Pump Suction Fittings

1.3 RELATED WORK
   A. Section 23 21 00 - Hydronic Piping

1.4 REFERENCES
   A. ANSI/ASME - Boilers and Pressure Vessels Code (BPVC)

1.5 REGULATORY REQUIREMENTS
   A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section VIII for manufacture of tanks.

1.6 QUALITY ASSURANCE
   A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.7 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 23 00 00.
   B. Submit shop drawings and product data for manufactured products and assemblies required for this project.
   C. Include component sizes, rough in requirements, service sizes, and finishes. Include product description, model number and dimensions.
   D. Submit inspection certificates for pressure vessels.
   E. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.8 OPERATION AND MAINTENANCE DATA
A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

1.10 GAUGES AND GAUGE CONNECTIONS

A. Furnish and install Ashcroft No. 1279A Duragauges on both suction and discharge sides of pumps, complete with Ashcroft No. 1095 lever handle shut-off cocks, and Ashcroft No. 1106B pulsation piston type dampeners, or approved equal. Porous type will not be accepted. Gauges shall have stainless steel movement and be accurate to 0.5%. Gauges shall be in PSI. Gauges shall have back connection when used on a panel; otherwise they shall have bottom connections. The graduation of the dials and the arrangement of the mechanisms shall conform to the pressure range details shown on the Drawings.

B. Combination pressure or vacuum gauges shall be Ashcroft Duragauges Number 1279A, with an appropriate vacuum range, or approved equal. The accessories for these gauges shall conform to those prescribed for pressure gauges.

C. Furnish and install, where noted or indicated on the accompanying Drawings or called for elsewhere in these Specifications, gauge connections complete with Ashcroft No. 1095 lever handle union shutoff cocks, or approved equal. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.

C. Support pump fittings with floor mounted pipe and flange supports.

END OF SECTION 23 06 20
SECTION 23 07 16 – EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES
   A. Equipment insulation
   B. Covering
   C. Breaching insulation

1.3 REFERENCES
   G. ASTM C533 – Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
   H. ASTM C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
Q. UL 723 – Test for Surface Burning Characteristics of Building Materials

1.4 SUBMITTALS
A. Submit under provisions of Section 23 00 00.
B. Product Data: Provide product description, list of materials and thickness for equipment scheduled.
C. Samples: Submit two samples of any representative size illustrating each insulation type.
D. Manufacturer’s Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE
A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with UL 723/ASTM E84.

1.6 QUALIFICATIONS
A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.
B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.
C. Store insulation in original wrapping and protect from weather and construction traffic.
D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS
A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 GENERAL
A. Unless otherwise noted, equipment shall be insulated with same insulation type and thickness as is used for piping which equipment serves.

2.2 PUMPS:
A. Each water pump shall not be insulated but the insulation of the connecting piping shall be continued up to the face of the flanges on the piping connection to the pump and any bare metal
that projects over the bed plate of the pump and from which condensation might drip onto the floor.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that equipment has been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION
A. Install materials in accordance with manufacturer's instructions.
B. Do not insulate factory insulated equipment.
C. On exposed equipment, locate insulation and cover seams in least visible locations.
D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory applied or field applied.
   2. Finish with glass cloth and vapor barrier adhesive.
   3. Insulate entire system.
G. Inserts and Shields:
   1. Application: Equipment 2 inches diameter or larger.
   2. Shields: Galvanized steel between hangers and inserts.
   3. Insert location: Between support shield and equipment and under the finish jacket.
   4. Insert configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Heavy density insulating material suitable for the planned temperature range.
H. Finish insulation at supports, protrusions, and interruptions.
I. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.
J. For exterior applications, provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.
K. Do not insulate over any nameplate or ASME stamps. Bevel and seal insulation around such.
L. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

M. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

N. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

O. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

P. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 15A.

Q. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

R. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer’s recommendations.

3.3 INSULATION APPLICATION SCHEDULE

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Service Temperature</th>
<th>Insulation Type</th>
<th>Insulation Thickness</th>
<th>Jacket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps</td>
<td>Per section 2.2 above</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION 23 07 16
SECTION 23 07 19 – PIPING INSULATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. 23 00 00 -- Basic Mechanical Requirements
   B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors
   C. 23 05 53 -- Mechanical Identification

1.2 SECTION INCLUDES
   A. Piping insulation
   B. Jackets and accessories

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION
   A. Section 23 21 00 - Hydronic Piping: Placement of hangers and hanger inserts.

1.4 RELATED SECTIONS
   A. 23 00 00 General Mechanical Requirements

1.5 REFERENCES
   A. ASTM B209   Aluminum and Aluminum Alloy Sheet and Plate.
   D. ASTM C335   Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
   E. ASTM C449   Mineral Fiber Hydraulic setting Thermal
   G. ASTM C533   Calcium Silicate Block and Pipe Thermal Insulation.
   H. ASTM C534   Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   I. ASTM C547   Mineral Fiber Preformed Pipe Insulation.
   J. ASTM C552   Cellular Glass Block and Pipe Thermal Insulation.
   K. ASTM C578   Preformed, Block Type Cellular Polystyrene Thermal Insulation.
   L. ASTM C585   Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
N. ASTM D1056 Flexible Cellular Materials Sponge or Expanded Rubber.
O. ASTM D2842 Water Absorption of Rigid Cellular Plastics.
P. ASTM E84 Surface Burning Characteristics of Building Materials.
S. UL 723 Surface Burning Characteristics of Building Materials.
T. ASHRAE 90.1 – Energy Standard for Buildings Except Low Rise Residential Buildings

1.6 SUBMITTALS
A. Submit under provisions of Section 23 00 00.
B. Product Data: Provide product description, list of materials ‘k’ value, ‘R’ value, mean temperature rating, and thickness for each service, and locations.
C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.
D. Manufacturer’s Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.7 QUALITY ASSURANCE
A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84 89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.
B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 23 00 00.
C. All piping shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
D. To be considered, alternate materials shall have equivalent thermal and moisture resistance of the specified materials.
1.8 QUALIFICATIONS
A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.
B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years’ experience specializing in the trade.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, protect, and handle products to site under provisions of Section 23 00 00.
B. Deliver materials to site in original factory packaging, labeled with manufacturer’s identification, including product thermal ratings and thickness.
C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.10 ENVIRONMENTAL REQUIREMENTS
A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.
C. All insulation materials to be asbestos free.

PART 2 - PRODUCTS

2.1 TYPE D: FIBERGLASS
A. Install insulation on pump and pipe to match existing. Owens Corning or equal glass fiber insulation piping insulation with a “K” factor of 0.23 BTU-In/Hr.-degree F at 75°F and 0.32 BTU-In/Hr.-degree F at 250°F
1. Rated maximum service temperature of 850°F.
2. Maximum density of 3.5-5.5 lbs/ft³
3. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.
4. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
5. Certified to meet the requirements of ASTM C795 for use over stainless steel.
6. Rated as noncombustible when tested in accordance with ASTM E136.
7. Insulation treated with water resistant resin on the surface and within each layer of the insulation.
8. Install product using manufacturer’s recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.
PART 3 - INSTALLATION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer’s instructions in the absence of specific instruction herein.
B. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the “90°” position, with the seam lapped such that the lap is directed down.
C. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
D. For insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

3.3 INSERTS, SUPPORTS AND SHIELDS

A. Application: Piping 3/4 inch diameter or larger for all systems except direct buried.
B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for insulated pipes 3/4” and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

<table>
<thead>
<tr>
<th>Nominal IPS</th>
<th>Metal Thickness of Shield</th>
<th>Lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>up thru 2”</td>
<td>14 gauge</td>
<td>12”</td>
</tr>
<tr>
<td>thru 6”</td>
<td>12 gauge</td>
<td>16”</td>
</tr>
<tr>
<td>and above</td>
<td>10 gauge</td>
<td>20”</td>
</tr>
</tbody>
</table>
C. Insert Location: Between support shield and piping and under the finish jacket.
D. Insert Configuration: Minimum 2” inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.
E. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.
F. The shields at support points shall be secured with ½” x 0.016” stainless steel bands and seals.
G. Finish insulation at supports, protrusions, and interruptions.
H. In lieu of the above the following system of support may be used:
1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft³ phenolic foam material to withstand the bearing loads transmitted from the pipe to the support; it shall extend for at least 1" on either side of the support to allow sealing of the joints with the pipe insulation jacket.

2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1" thickness of 2.2 lbs/ft³ standard insulation including FSK/ASJ vapor barrier.

Table 1: K Block Support Centers

<table>
<thead>
<tr>
<th>Nominal Pipe Size (Inches)</th>
<th>3/4</th>
<th>1 1/4</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max support centers (feet)</td>
<td>6.5</td>
<td>6.5</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Sch 80 pipe filled with water covered with 1&quot; of Standard Insulation</td>
<td>6.5</td>
<td>6.5</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Metal Saddle Gauge (Galvanized Steel)</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>16</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>114</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Length of HLB Block (inches)</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

3. The Insulation at supports shall be Foamglas HLB Blocks. HLB Blocks shall be faced with factory applied FSK/ASJ vapor barrier and fitted with a galvanized steel 1800 saddle bonded to the bottom section of the HLB Block, for all pipe sizes 1 1/2" and larger.

4. The vapor barrier shall be completed by the use of a FSK/ASJ overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.

5. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval.

6. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

I. For purpose of definition in this Specification: “concealed” areas are those areas which cannot be seen by the building occupants, and “exposed” areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

J. Self Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.
K. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140 degrees F on the hot surfaces.

L. Special Protection: All insulated piping in the mechanical rooms within 8'-0" of the floor shall be encased in a protective aluminum jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

3.4 PAINTING

A. No painting is required for this scope.

3.5 INSULATION APPLICATION SCHEDULE

A. All insulation R-Values shall be the greater of what is scheduled below or required to meet ASHRAE 90.1-2010.

B. Where minimum scheduled thickness exceeds the thickness required to meet the minimum R-Value, provide the minimum scheduled thickness. Insulation Thickness depends upon insulation type used.

<table>
<thead>
<tr>
<th>Service</th>
<th>Pipe Dia. (Inches)</th>
<th>Fluid Temp (°F)</th>
<th>Min. R-Value (ft²°F-hr/BTU in)</th>
<th>Insulation Thickness (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water</td>
<td>&lt;1&quot;</td>
<td>&lt;40</td>
<td>Type B</td>
<td>Type C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 to &lt;1 1/2&quot;</td>
<td></td>
<td>3.2</td>
<td>1 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.4</td>
<td>1 1</td>
</tr>
<tr>
<td></td>
<td>1 1/2&quot; to &lt;4&quot;</td>
<td></td>
<td>5.7</td>
<td>1 1</td>
</tr>
<tr>
<td></td>
<td>4&quot; to &lt;8&quot;</td>
<td></td>
<td>4.7</td>
<td>1 1</td>
</tr>
<tr>
<td></td>
<td>&gt;8&quot;</td>
<td></td>
<td>4.3</td>
<td>1 1/2 1</td>
</tr>
</tbody>
</table>

1. All insulation R-Values shall be the greater of what is scheduled above or required to meet ASHRAE 90.1-2010.

2. Minimum ‘R’ does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.

3. A minus 15 percent tolerance on the insulation performance listed shall be permitted for manufacturers’ standard insulation systems.

END OF SECTION 23 07 19
SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEMS
EXISTING BUILDING WITH EXISTING DDC SYSTEM
INFORMATION ON PREVIOUSLY INSTALLED EQUIPMENT IS FOR INFORMATION ONLY.
ADDITIONAL EQUIPMENT AS NOTED WILL BE REQUIRED AS NOTED ON THE DRAWINGS.

PART 1 GENERAL

1.00 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
A. Section 23 00 00 – Basic Mechanical Requirements
B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES
A. Control equipment.
B. Software.

1.04 RELATED SECTIONS
A. Section 26 05 00 - Equipment Wiring Systems.

1.05 REFERENCES
B. ASME MC85.1 - Terminology for Automatic Control.

1.06 DEFINITIONS
A. Ensure terminology used in submittals conforms to ASHRAE 85.

1.07 SYSTEM DESCRIPTION
A. The system is an existing JCI system. The extend of this work shall be to replace VFDs and pumps and to reconnect to the system so that the new pumps operate as in the original sequence of operation for the building.
B. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to the existing Metasys Campus Building Management System.
C. Central and remote hardware, software, and interconnecting wire and conduit.
D. Terminal unit controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, pneumatic or electric unless indicated otherwise.
E. The DDC systems shall be installed by JCI under a direct contract with the General Contractor. JCI shall provide “open-book” pricing to the General Contractor and UTHSC-H per the existing UTHSC-H/JCI agreement.

F. All sensors that are installed in insulated pipe or ductwork shall be installed with standoffs to allow proper insulation of all materials and continuation of vapor barriers.

1.08 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Shop Drawings:
   1. Trunk cable schematic showing programmable control unit locations, and trunk data conductors.
   2. List of connected data points, including connected control unit and input device.
   3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
   4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
   5. Descriptive data and sequence of operation of operating, user, and application software.
   6. Provide one additional submittal above that which is asked for in Division 1 to be distributed by UTHSC-H to the IT department for verification.

C. Product Data: Provide data for each system component and software module.

D. Manufacturer’s Installation Instructions: Include for all manufactured components.

1.09 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01 77 00.

B. Accurately record actual location of control components, including panels, thermostats, and sensors.

C. Revise shop drawings to reflect actual installation and operating sequences.

D. Include data specified in "Submittals" in final "Record Documents" form.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01 77 00.

B. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.

C. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
D. Include graphics of the controlled system as they appear on the system graphics with variable, adjustable and fixed points with showing identified and numbered systems, system components and devices.

E. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

### 1.11 QUALIFICATIONS

A. Manufacturer: JCI controls.

B. Installer: JCI controls

C. Design system software under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.

### 1.12 PRE-INSTALLATION CONFERENCE

A. Convene a conference one week prior to commencing work of this Section, under provisions of Section 01200.

B. Require attendance of parties directly affecting the work of this Section.

### 1.13 COORDINATION

A. Coordinate work under provisions of Section 00 10 05.

B. Ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

D. Coordinate the startup and control sequence verification with the test and balance agent.

E. Ensure system is completed and commissioned.

### 1.14 WARRANTY

A. Provide five year warranty under provisions of Section 01 78 36.

B. Warranty: Include coverage for field programmable micro-processor based units.

### 1.15 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.

2. Limiting copying.

3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

PART 2 PRODUCTS
2.00 MANUFACTURERS OF CONTROLS
   A JCI

2.01 GENERAL DESCRIPTION
   A The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks. Prior to submittal update equipment to the latest technology and coordinate with the Engineer.
   B The Building Management System shall consist of the following:
      1 Standalone Network Automation Engine(s)
      2 Field Equipment Controller(s)
      3 Input/Output Module(s)
      4 Local Display Device(s)
      5 Portable Operator's Terminal(s)
      6 Distributed User Interface(s)
      7 Network processing, data storage and communications equipment
      8 Other components required for a complete and working BMS
   C The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
   D System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
      1 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
      2 The System shall maintain all settings and overrides through a system reboot.
      3 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
   E Conduit and boxes shall be installed and supported per 23 05 29. Controls conduit shall be ¾” EMT that is blue in color. The boxes shall be type 1900 and where the mixing box is located inside of the office area, the conduit shall be stubbed on from the junction box into the office space as close to the box as possible above the ceiling.

2.02 FIELD DEVICES
   A Thermostats
      1 Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer’s standard finish.
2 Actuation / Control Type

3 Primary Equipment
   (a) Controls shall be provided by equipment manufacturer as specified herein.
   (b) All damper and valve actuation shall be electric.

4 Air Handling Equipment
   (a) All air handers shall be controlled with a HVAC-DDC Controller
   (b) All damper and valve actuation shall be electric.

PART 3 EXECUTION

END OF SECTION
SECTION 23 20 00 – HVAC PUMPS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements
B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED

A. In-line pumps

1.3 RELATED WORK

A. Section 23 05 13 – Motors
B. Section 23 05 16 – Expansion Compensation
C. Section 21 05 48 - Vibration Isolation
D. Section 23 07 19 - Piping Insulation
E. Section 23 07 16 - Equipment Insulation
F. Section 23 21 00 - Hydronic Piping
G. Section 23 06 20.13 - Hydronic Specialties
H. Section 26 29 23 – Variable Speed Drives

1.4 REFERENCES

A. ANSI/UL 778 - Motor Operated Water Pumps

1.5 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum three years experience.
B. Alignment: Base mounted pumps shall be aligned by qualified millwright and alignment certified.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.
B. Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
C. Submit manufacturer's installation instructions under provisions of Section 23 00 00

1.7 OPERATION AND MAINTENANCE DATA
A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

1.9 EXTRA PARTS

A. Provide one extra set of mechanical seals for pumps under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Armstrong

B. Aurora

C. Bell & Gossett

D. Gould

E. Paco

F. Taco

G. Substitutions: Under provisions of Section 23 00 00

2.2 SPLIT-COUPL ED VERTICAL IN-LINE (VIL) PUMPS

A. General: Furnish and install vertical in-line, single-stage, single or double suction, flexible coupled, bronze fitted centrifugal type, mechanical seal pumps of the size, capacity and head scheduled on the Drawings. The selected pump operation point shall have a minimum efficiency as scheduled and impeller diameter shall not exceed 90% of the cutwater diameter for the selected pump casing size. All pumps shall have dynamically balanced impellers. Shutoff head shall be at least 110 percent of design head but shall not exceed 140 percent of design head, unless scheduled otherwise. Provide Armstrong Series 4300 (or approved equal) split-coupled Type VIL units, with rigid spacer type coupling.

B. Pumps: Pumps, casings, flanges and seals shall be suitable for operation at 150 psig minimum, and shall be suitable for use within the normal temperature operating ranges of the system in which they are installed. Pumps shall have stainless steel shafts, stainless steel sleeves, cast-iron or bronze casing wear rings, bronze impeller wear rings, external seal water piping, cast-iron deflectors, stainless steel impeller keys, coated fiber packing gaskets and steel casing studs and bolts.

C. Provide factory manufactured coupling guard meeting OSHA standards with each pump.

D. Impellers:

1. All pumps shall have dynamically balanced impellers and those with motors 30 HP or greater shall be factory capacity tested after final assembly. Certified factory pump
performance test curves shall be submitted indicating capacity, head, horsepower and efficiency from shutoff to 125% of design flow.

2. The impeller selected shall not exceed 90% of the cutwater diameter for the pump casing size. This shall be clearly certified on the pump submittal.

E. Seals: Mechanical Seals - Shall be Stainless Steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plate. Provide factory installed flush line with manual vent.

F. All pumps shall be equipped with mechanical seals suitable for the service intended.
   1. All split coupled pumps shall be provided with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication.
   2. Seal flush line accessories, if required to improve seal chamber cleanliness: Supply in the flush line to the mechanical seal to suit the working pressure encountered.

G. Seal Protection: The mechanical seals on all condenser water pumps shall be provided with a 50 micron cartridge filter and sight flow indicator. Piping shall be stainless steel braided hose and shall be provided with isolation valves as recommended by the in-line filter manufacturer or as shown on the Drawings. Filters shall be changed, by the installing contractor, after system is flushed and on a regular basis until turned over to the owner.

H. Motors: Pump motors shall be Energy Efficient 1750 RPM open drip-proof type (indoors) or TEFC (outdoors), and shall be selected to drive the pump through its characteristic curve from zero flow to 125% of design flow without exceeding rated full load nameplate horsepower. Refer to Section XX for additional motor requirements and minimum efficiencies. All motors served by a VSD shall be supplied with integral shaft grounding kit.

I. Miscellaneous:
   1. Pumps shall be free of flashing and cavitation at all flow rates from 25% to 125% of design flow under the suction conditions of the pump installation.
   2. Critical speed of each pump shall be at least 115% of the running speed scheduled.
   3. Each motor shall have a maximum speed of 1750 RPM and shall be selected to drive the pump through its characteristic curve, from zero flow to 125% of design flow without exceeding rated nameplate horsepower.

J. Factory Tests: Pumps with drive motors 30 horsepower and larger shall be individually factory capacity tested after final assembly. Provide certified copies of test results showing capacity, head, horsepower, and efficiency at flow rates from shut off to 125% of design flow. The certification shall also indicate results of factory dynamic balance and pressure testing. Provide certified performance curves for pumps less than 30 horsepower.

2.3 IN-LINE CENTRIFUGAL PUMPS:

A. General: Provide circulating pumps with all-bronze construction of the size, type, and capacity scheduled or shown on the Drawings. Pumps shall be fitted with a dynamically balanced brass enclosed type impeller with mechanical seal. Mechanical seal shall be Type 1 or Type 2 material, Code BP-1D1 as manufactured by John Crane Company or an approved equal, suitable for service specified. Motor shall have a maximum speed of 1750 rpm. Pumps, casings, flanges, and seals shall be suitable for operation with the working pressures and temperatures indicated. The scheduled working pressure applies to the entire pump assembly.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in accordance with manufacturer’s instructions.

B. Provide access space around pumps for service. Provide no less than a minimum of three feet, not including piping and piping appurtenances.

C. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 15 percent of midpoint of published maximum efficiency curve.

D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over. Refer to Section 23 05 48 for vibration isolation.

E. Provide line sized shut-off valve (ball or butterfly) and strainer on pump suction, and line sized soft seat check valve and balancing (ball or butterfly with memory stop) valve on pump discharge.

F. Provide air cock and drain connection on horizontal pump casings.

G. Provide drains for bases and seals, piped to and discharging into floor drains.

H. Lubricate pumps before start-up.

I. Alignment: A qualified millwright shall check, align and certify pumps. A reverse alignment procedure utilizing laser instruments shall be used. Alignment shall be performed in both hot and cold operating extremes. The maximum parallel and angular misalignment shall not exceed .002 inch. Record and deliver copies of the alignment report to the Owner’s RCM and include copy of the report in the O&M Manual.

J. Vibration Testing: Vibration velocity readings shall be taken at all bearing locations of all pumps. Pumps driven by variable speed drives shall be tested throughout their range of speeds. Vibration shall not exceed 0.15 inch/second (peak). Record and deliver copies of the test report to Owner’s RCM and include report in the O&M Manual.

END OF SECTION 23 20 00
SECTION 23 20 10– PIPING, VALVES AND FITTINGS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements
B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Pipe and Pipe Fittings
B. Valves

1.3 RELATED SECTIONS

A. Section 23 05 16 – Expansion Compensation
B. Section 23 05 48 – Vibration Isolation
C. Section 23 07 19 – Piping Insulation
D. Section 23 21 00 – Hydronic Piping
E. Section 23 06 20.13– Hydronic Specialties

1.4 REFERENCES

A. ASME – Boiler and Pressure Vessel Code (BPVC)
B. ASME BPVC Sec. IX – Welding and Brazing Qualifications
C. ASME B16.1 – Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
D. ASME B16.3 – Malleable Iron Threaded Fittings: Classes 150 and 300
E. ASME B16.4 – Grey Iron Threaded Fittings: Classes 125 and 250
F. ASME B16.5 – Pipe Flanges and Flanged Fittings NPS ½ through 23 Metric/Inch Standard
G. ASME B16.9 – Factory-Made Wrought Butt Welding Fittings
H. ASME B16.18 – Copper Alloy Solder Joint Pressure Fittings
I. ASME B16.22 – Wrought Copper and Bronze Solder-Joint Pressure Fittings
J. ASME B16.26 – Copper Alloy Fittings for Flared Copper Tubes
K. ASME B16.34 – Valves Flanged, Threaded, and Welding End
L. ASME B31.1 – Power Piping
M. ASME B31.3 – Process Piping
N. ASME B31.9 – Building Service Piping
O. ASTM A47 - Ferric Malleable Iron Castings
P. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
Q. ASTM A105 – Standard Specification for Carbon Steel Forgings for Piping Applications
U. ASTM A181 – Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
V. ASTM A182 – Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
W. ASTM A234 - Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
Y. ASTM B32 – Standard Specification for Solder Metal
BB. for Steam or Valve Bronze Castings
CC. ASTM B75 - Standard Specification for Seamless Copper Tube
DD. ASTM B88 - Standard Specification for Seamless Copper Water Tube
EE. ASTM B99 – Standard Specification for Copper-Silicon Alloy Wire for General Applications
GG. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
HH. ASTM B302 – Standard Specification for Threadless Copper Pipe (TP), Standard Sizes
II. AAA.AWS A5.8 - Brazing Filler Metal.
JJ. MSS SP-25 – Standard Marking System for Valves, Fittings, Flanges, and Unions
KK. NCPWB - Procedure Specifications for Pipe Welding

1.5 SUBMITTALS
A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00.

B. Record actual locations of valves, etc. and prepare valve charts.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welder’s Certification: In accordance with ASME BPVC Sec. IX. Submit welder’s certifications prior to any shop or field fabrication. Welder’s certifications shall be current within six months of submission.

D. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years’ documented experience.

B. Installer: Company specializing in performing the work of this section with minimum of three years’ documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.12 EXTRA MATERIALS
A. Furnish under provisions of Section 23 00 00.

B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 STEEL PIPING:

A. Section applies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water, hot water, steam, and steam condensate.

B. Pipe: Unless otherwise indicated, chiller and boiler plant piping shall be Schedule 40, and underground and building piping shall be Standard weight, Grade A or B, seamless black steel pipe conforming in all details to Standard ASTM Designation A53, A106, and A135, latest revisions. Steam condensate shall be Schedule 80.

C. Fittings:

1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9, latest edition, as made by Weldbend, Tube Turns, or Hackney Ladish Inc. Attach only to pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed, or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting is to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

2. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Grinnell Company, Crane Company, or Walworth Company manufacture (Class 300 for unions).

D. Fabrication:

1. Piping shall be fabricated according to the latest ASME/ANSI B31 Code for Pressure Piping. Welded piping and fittings in chiller and boiler plants shall be fabricated in accordance with ASME/ANSI Standard B31.1 – Power Piping. Direct buried piping mains shall be fabricated in accordance with ASME/ANSI Standard B31.3 – Process Piping. Standard B31.9 – Building Services Piping may be used within buildings. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal in welds. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size, and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. In no cases shall Schedule 40 pipe be welded with less than three passes, including one stringer/root, one filler, and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler, and one lacer. In all cases, the weld must be filled before the cap weld is added.

8. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

E. Weld Testing:

1. All welds are subject to inspection, visual, X-ray and/or Ultrasound, for compliance with specifications. The owner will, at the owner’s option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the owner. The contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and re-testing of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1, B31.3, and B31.9, due to the discovery of poor, unacceptable, or rejected welds.

2. Welds lacking penetration, containing excessive porosity or cracks, or found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the ASME/ANSI B31 Code for Pressure Piping, current edition.

2.2 VALVES:

A. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this project. All bronze and iron body gate and globe valves shall be the product of one manufacture for each project. Manufacturers of
other types may not be mixed on the same project; i.e., all butterfly valves shall be of the
same manufacture, all ball valves shall be of the same manufacture, etc.

B. All valves used in circulating systems, plumbing and steam systems (low and medium
pressure) shall be Class 150 SWP. Class 300 valves shall be constructed of all ASTM
B-61 composition. All gate, globe and angle valves shall be union bonnet design. Metal
used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371
Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written
approvals must be secured for the use of alternative materials. Alloys used in all bronze
ball, gate, globe, check, or angle valves shall contain no more than 15% zinc. No
yellow brass valves will be allowed.

C. All iron body valves shall have the pressure containing parts constructed of ASTM
designated of 126 class B iron. Stem material shall meet ASTM B16 Alloy 360 or ASTM
371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet
with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is
preferred on yoke cap for maintenance lubrication of the yoke bushing.

D. All cast steel body valves shall have the pressure containing parts constructed of ASTM
designation A-216-GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet
outside and screw and yoke design with pressure-temperature rating conforming to ANSI
Wedge (gate valves) may be solid or flexible type and shall meet ASTM A-182-F6
chromium stainless steel on valves from 2" to 6". Sizes 8" and larger may be
A-216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced
carbon steel or 13% chromium A-182-F6 stainless. Handwheels shall be A47 Grade
35018 malleable iron or Ductile Iron ASTM A536.

E. All forged steel body valves shall have the pressure containing parts constructed of
ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM A-182-F6
chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI
B16-34 pressure-temperature rating.

F. All valves shall be repackable, under pressure, with the valve in the full open position. All
gate valves, globe valves, angle valves and shut off valves of every character shall have
malleable iron hand wheels, except iron body valves 2-1/2" and larger which may have
either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

G. Packing for all valves shall be free of asbestos fibers and selected for the
pressure-temperature service of the valve. It is incumbent upon the manufacturer to
select the best quality, standard packing for the intended valve service. At the end of one
year, period spot checks will be made, and should the packing show signs of hardening
or causing stem corrosion then all valves supplied by the manufacturer shall be repacked
by the Contractor, at no expense to the Owner, with a packing material selected by the
Owner.

H. Valves 12" and larger located with stem in horizontal position shall be drilled and tapped
in accordance with MSS-SP-45 to accommodate a drain valve and equalizing by-pass
valve assembly.

I. Standards of Quality for Valves:
E&C Engineers & Consultants

23 20 10- 7
E&C No. 3627.00

### Stockham

<table>
<thead>
<tr>
<th>Size</th>
<th>Type</th>
<th>Class</th>
<th>Milwaukee</th>
<th>Nibco</th>
<th>Or as noted</th>
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<tr>
<td>2&quot; &amp; smaller</td>
<td>Globe, Angle &amp; Balancing Valve</td>
<td>Chilled Water</td>
<td>150</td>
<td>590T</td>
<td>T-235</td>
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<tr>
<td>2-1/2&quot; &amp; larger</td>
<td>Globe, Angle &amp; Balancing</td>
<td>Plumbing, Chilled Water, Valve</td>
<td>125</td>
<td>F-2981</td>
<td>F-718-B</td>
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<td>2&quot; &amp; smaller</td>
<td>Check Valve</td>
<td>All Water Systems</td>
<td>150</td>
<td>510</td>
<td>T-433</td>
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<tr>
<td>2-1/2&quot; &amp; Stockham larger</td>
<td>Check Valve</td>
<td>All Water Systems</td>
<td>150</td>
<td>1400</td>
<td>W-920-W</td>
</tr>
</tbody>
</table>

* Requires extended stem in insulated lines.

** Valves 8" and larger, and valves used for balancing service regardless of size, shall have heavy duty weather proof encased gear operators.

*** Requires ball drip assembly.

**** All modulating ball valves shall be characterized.

#### 2.3 UNIONS:

A. Provide and install two-piece unions at proper points to permit removal of pipe, valves and various equipment and/or machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at all valves, equipment items, machinery items and other special pieces of apparatus. Unions 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to EPCO.

C. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a two-piece dielectric union shall be used at the transition.

#### 2.4 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A181 Grade I or II or ASTM A105-71 as made by Tube Turns or Hackney Ladish Inc. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9, and, in addition, shall have the laboratory control
number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and be rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and be rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

C. Flange Gaskets

1. Gaskets shall be placed between the flanges of all flanged joints.

2. Gaskets for steam piping - All steam flange joints shall use Flexitallic Class 150 spiral wound for low pressure applications and Flexitallic Class 300 spiral wound gaskets for medium or high pressure applications. Raised and flat face flange gaskets shall be Flexitallic compression gauge (CG) style. External ring shall be Type 304 stainless steel and color coded yellow. Filler material shall be Flexite Super and color coded with pink stripe. Equivalents may be submitted with all design data so that an evaluation of the gasket can be made.

3. Gaskets for all other applications: Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16” thick asbestos free material recommended for service by Anchor, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

4. Spares - Contractor shall provide ten spares for every flange size and rating.

D. Flange Bolt Installation:

1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.

2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

<table>
<thead>
<tr>
<th>Nominal Bolt Dia. (Inch)</th>
<th>Torque (Foot-Pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>6</td>
</tr>
<tr>
<td>0.3125</td>
<td>12</td>
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<tr>
<td>0.375</td>
<td>18</td>
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<td>1.0</td>
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<tr>
<td>1.125</td>
<td>533</td>
</tr>
<tr>
<td>1.25</td>
<td>750</td>
</tr>
</tbody>
</table>
3. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.

4. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30% of full torque increases.

5. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.

6. Inspection - Owner shall verify hot torqueing of all medium and high pressure steam flange bolts.

PART 3 - EXECUTION

Refer to other Sections for service specific requirements.

3.1 EXAMINATION

A. Verify excavations under provisions of Section 23 00 00.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

3.4 ERECTION TOLERANCES
A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

END OF SECTION 23 20 10
SECTION 23 21 00 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED
   A. Pipe and Pipe Fittings
   B. Valves
   C. Heating Water Piping System
   D. Glycol Water Piping System
   E. Chilled Water Piping System
   F. Condenser Water Piping System

1.3 SCOPE OF WORK
   A. Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with, or properly incidental to, the construction of complete HVAC piping and accessories systems as indicated on the Drawings, reasonably implied therefrom, or as specified herein unless specifically excluded.

1.4 RELATED WORK
   A. Section 23 20 10. - Piping, Valves and Fittings
   B. Section 21 05 48. - Vibration Isolation
   C. Section 23 07 19. - Piping Insulation
   D. Section 23 06 20.13. - Hydronic Specialties

1.5 REFERENCES
   A. ANSI/ASME - Boiler and Pressure Vessel Code
   B. ANSI/ASME Sec 9 - Welding and Brazing Qualifications
   C. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300
   D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV
   E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
F. ANSI/ASME B31.9 - Building Services Piping
G. ANSI/AWS A5.8 - Brazing Filler Metal
H. ANSI/AWS D1.1 - Structural Welding Code
I. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
J. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
K. ASTM B32 - Solder Metal
L. ASTM B88 - Seamless Copper Water Tube
M. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
N. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
O. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)

1.6 REGULATORY REQUIREMENTS
A. Conform to ANSI/ASME B31.9

1.7 QUALITY ASSURANCE
A. Valves: Manufacturer's name and pressure rating marked on valve body.
B. Welding Materials and Procedures: Conform to ANSI/ASME SEC. 9, and applicable state labor regulations.
C. Welders Certification: In accordance with ANSI/AWS D1.1.

1.8 SUBMITTALS
A. Submit product data under provisions of Section 23 00 00.
B. Include data on pipe materials, pipe fittings, valves, and accessories.
C. Include welder's certification of compliance with ANSI/AWS D1.1.
D. Contractor to provide cleaning and flushing plan consisting of the following:
   1. Markup of plans indicating which sections are to be flushed at a time, the location of flushing bypasses and pump connections, and the anticipated velocity at each section of pipe.
   2. Performance data on pump to be used for flushing

1.9 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Section 23 00 00.
B. Store and protect products under provisions of Section 23 00 00.
C. Deliver and store valves in shipping containers with labeling in place.
PART 2 - PRODUCTS

2.1 WALL, FLOOR AND CEILING PLATES:
   A. See Section 23 05 29.

2.2 SLEEVES, INSERTS, AND FASTENINGS:
   A. See Section 23 05 29.

2.3 CHILLED AND HEATING WATER PIPING - ABOVE GROUND:
   A. See Section 23 20 10 and 23 06 20.
      1. All piping shall be Standard Weight black steel pipe.
      2. All unions: Class 300.
      3. Low Zone (0' to 150' elevation)
         a. Fittings on piping 2-1/2" and larger shall be standard weight butt welding type. Flanges shall be 150# welding neck type. Standard weight Weld-O-Lets, Thread-O-Lets, and shaped nipples may be used only when take-off is 1/3 or less nominal size of main. Bushings shall not be used.
         b. Fittings on piping 2" and smaller shall be Class 150 black malleable iron screw fittings. (Class 300 for unions.)
         c. Valves and strainers: Class 150.

PART 3 - EXECUTION

3.1 PREPARATION
   A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
   B. Remove scale and dirt on inside and outside before assembly.
   C. Prepare piping connections to equipment with flanges or unions.
   D. After completion, fill, clean, and treat systems. Refer to Section 22 13 16.UT

3.2 INSTALLATION
   A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
   B. Install piping to conserve building space, and not interfere with use of space and other work.
   C. Group piping whenever practical at common elevations.
   D. Provide clearance for installation of insulation, and access to valves and fittings.
   E. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13
   F. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to weld area.

H. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 91 00.

I. Install valves with stems upright or horizontal, not inverted.

3.3 FABRICATION OF PIPE:

A. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage.

B. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site.

C. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

D. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.

E. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from lying on the ground shall be removed.

F. Procedure for Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.

3.4 APPLICATION

A. Grooved mechanical couplings and fasteners may be used only in accessible locations and for pump fit-up assemblies, when approved by Owner in writing.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install calibrated balancing valves for throttling, bypass, or manual flow control services.

E. Provide spring loaded check valves on discharge of condenser water pumps.

F. Use lug end butterfly valves to isolate equipment.

G. Provide 3/4 inch ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. [Pipe to nearest drain.]

3.5 PIPE PRESSURE TESTS:

A. See Section 23 00 00

3.6 CLEANING AND FLUSHING OF WATER SYSTEMS
A. Water circulating systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, any and all other material foreign to water being circulated.

B. 

C. Contractor shall add inhibitor to the cleaning and flushing chemicals if, once the system is approved as clean, there is any delay in connecting the new system to the existing system. This is to prevent any corrosion after the new pipe is clean.

END OF SECTION 23 21 00
SECTION 23 29 23 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES
   A. Variable Frequency Drives

1.3 RELATED SECTIONS
   A. Section 23 05 13 - Motors
   B. Section 23 05 48 - Vibration Isolation
   C. Section 23 20 00 – HVAC Pumps
   D. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

1.4 REFERENCES
   A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings
   B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings
   C. AMCA 99 - Standards Handbook
   D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes
   E. AMCA 300 - Test Code for Sound Rating Air Moving Devices
   F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices
   G. NEMA MG1 - Motors and Generators
   H. NFPA 70 - National Electrical Code
   I. IEEE - 112B, 587 and 519

1.5 SUBMITTALS
   A. Submit complete product data, shop drawings, and wiring diagrams, including the rated input current of the VFD. Data shall clearly indicate the current distortion produced by the VFD (submittal will not be approved prior to receiving this information). See paragraph 2.2E for requirements. Make submittals under the provisions of Section 23 00 00 and Division 01.
1. Where IEEE 519 analysis indicates that a 6 pulse VFD will satisfy the requirements specified within this section, Contractor shall submit request to use 6 pulse VFD. Contractor is to include credit for using a 6 pulse rather than 12 pulse VFD in submittal.

B. Product Data:

1. Provide literature that indicates dimensions, weights, capacities, performance, gages and finishes of materials, and electrical characteristics and connection requirements.

2. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring. Coordinate submittal with Direct Digital Controls supplier for interface with building control system.

3. Ratings, including voltage and continuous current and horsepower.

C. Shop Drawings:

1. Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

2. Dimensioned drawings. Outline dimensional drawings of each size and type of variable frequency drive (VFD) proposed for use on this project. Include top and bottom views showing conduit entry and exit space, front and side elevations showing arrangement of devices, ventilation and cooling provisions, required clearances, connection details, and mounting provisions.

D. Prior to Installation, Startup, and Testing:

1. Submit manufacturer's written installation instructions.

2. Submit written procedures for field testing to be performed under Part 3 of this Section. Procedures shall include prerequisite and initial conditions, a list of required test instruments, and forms for documentation of test results. Testing forms shall include the range of acceptance values for each recorded parameter.

E. Following Installation, Startup, and Testing. Submit the following information for record purposes in accordance with the requirements of Division 01, Submittals, prior to Owner acceptance.

1. Records. Final as-built drawings and information for items listed in paragraph 1.5B and 1.5C, this Section.

2. Certified factory production test reports, as specified in Part 3, this Section.

3. Manufacturer’s Field Start-up Report and Certification, as specified in Part 3, this Section.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for routine service, spare parts lists, and wiring diagrams.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.
1.8 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. UL Compliance:
   1. Comply with UL 508,
   2. Comply with UL 60947-4-1A for Motor Starters and Contactors.

C. IEEE Compliance:

D. NEMA Compliance:
   1. Comply with NEMA ICS 7.0, AC Adjustable Speed Drives.
   2. Comply with NEMA MG-1 for Motors.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.10 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB

B. Danfoss Graham
C. Substitutions: Under provisions of Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.2 GENERAL

A. The variable frequency drive (VFD) motor controller shall convert 208, 480 Volt, three-phase, 60 Hertz power to adjustable voltage (0 - 480V) and frequency (20 - 65 Hz.) three-phase, AC power for stepless motor speed control with a capability of 10:1 speed reduction.

B. The adjustable frequency controller shall be a space vector sine-coded Pulse-Width Modulated (PWM) or IGBT design. Modulation methods which incorporate "gear-changing" techniques are not acceptable.

C. The controller shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.

D. The variable frequency control shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other VFD's are operated from the same bus.

E. Individual or simultaneous operation of VFD's shall not add more than 5 percent total harmonic voltage distortion and no more than 5 percent total harmonic current distortion (per IEEE 519) to the normal bus.

1. VFD manufacturer shall perform harmonic analysis based on the electrical one-line diagram. The VFD manufacturer shall provide calculations specific to this installation, showing total harmonic voltage distortion is less than 5 percent.

2. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE Standard 519. The resultant power factor with the addition of the filter shall be a minimum of 97%. All VFD's shall include a minimum of 5 percent impedance reactors, no exceptions.

3. The VFD shall be provided with a harmonic filter that limits the current distortion to 5% or less. Assume a 98% power factor and nominal voltage and frequency for input conditions.

4. Contractor shall include base bid pricing for 12 pulse VFD as well as deduct pricing for 6 pulse VFD in bid.

F. The VFD shall be provided with a DDC System Interface/JCI Protocol Interface and be reconnected to the system and programmed to match the existing VFD programming.

G. The VFD shall include RFI/EMI filters to prevent high frequency noise interference from migrating back onto the power system and RFI interference with other equipment.

2.3 SCHEDULE

A. In general, capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the Owner.
B. Where rating of driven equipment furnished for this project is larger than scheduled or indicated on Drawings, provide variable speed drive suitable for driven equipment. Coordinate submittal data and unit selections with submittal data for driven equipment.

C. Provide VFDs as follows unless otherwise specified on the equipment schedule:
   1. For equipment that is redundant provide VFD without a constant speed bypass.
   2. For equipment that is not redundant provide VFD with a constant speed bypass.

2.4 BASIC DESCRIPTION

A. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz. despite incoming voltage variations.

B. The controller shall have a continuous output current rating of 100 percent of motor nameplate current.

C. The VFD shall be of the Pulse-Width Modulated type and shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-coded output voltage. The inverter output shall be generated by Darlington power transistors which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. The drive shall produce an output volts/Hertz pattern to produce adequate starting torque under all conditions and operate smoothly at all operating speeds on variable torque load.

2.5 FEATURES

A. The door of each power unit shall include a "POWER ON" light, a VFD fault light, a VFD run light, stop pushbutton, start pushbutton, a fault reset pushbutton, a "HAND-OFF-AUTOMATIC" selector switch, and a manual speed control potentiometer.

B. The VFD shall be software programmable to provide automatic restart after any individual trip condition resulting from overcurrent, overvoltage, undervoltage, or overtemperature. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a short time period.

C. A speed droop feature shall be included which reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.

D. Automatic restart after drive trip or utility failure, software selectable.

E. Speed profile. Individual adjustable settings for start, stop, entry, slope, and minimum and maximum speed points.

F. Process signal inverter. Software selectable to allow speed of drive to vary inversely with input signal.

G. A critical speed avoidance circuit will be included for selection of at least three critical speeds with a rejection band centered on that speed. The drive will ignore any speed signals requiring drive operation within the rejection band.
H. Proportional and integral setpoint process controller with menu driven selection and programming via door-mounted keypad.

I. Pick up a spinning load. The VFD shall be able to determine the motor speed and resume control of a motor which is spinning in either direction without tripping.

J. A door-mounted membrane keypad with integral 2-line, 24-character LCD display shall be furnished, capable of controlling the VFD and setting drive parameters, and shall include the following features:

1. The digital display must present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.

2. The digital keypad shall allow the operator to enter exact numerical settings in English engineering units. A plain English user menu shall be provided in software as a guide to parameter setting, (rather than codes). Drive parameters shall be factory set in EEPROM and resettable in the field through the keypad. Means of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.

K. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power.

L. Constant speed bypass shall be provided to allow the motor to run across the line in the event of VFD shutdown. The transfer from the VFD to the line shall be accomplished manually by means of a selector switch. The bypass circuitry shall be enclosed separate from the VFD in a NEMA-1 cabinet.

M. The bypass cabinet shall include a door-interlocked input circuit breaker, a VFD output contactor, a full-voltage starting contactor (both contactors electrically interlocked), a thermal overload relay to provide motor protection, a phase loss/undervoltage relay and a control power transformer. Mounted on the cabinet door shall be a two line LCD display to indicate status of the bypass operation (i.e. VFD output contactor failure or bypass contactor failure, etc), VFD bypass selector switch, motor fault light, power "ON" light, motor "ON" VFD light, and motor "ON LINE" light. The VFD shall be provided with a BacNet Protocol interface. The bypass shall have four digital inputs for individual safety interlocks and provide voltage and current reading on all 3 phases as well as KW.

N. The drive shall be provided with two isolated form C alarm contacts to indicate VFD failure and run status to the DDC.

O. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

P. Drives serving cooling tower fans shall have the ability to provide a blade breaking load to prevent the cooling tower fan from spinning backwards.

Q. Digital display indication of:

1. Speed demand in percent.

2. Output current in amperes.

3. Frequency in Hertz or RPM.

5. Total three-phase KW or output voltage.

R. At the factory with compatible motor, provide at least three lock-out ranges (50 rpm maximum each), two of which can be used to correct any run test problems.

2.6 SERVICE CONDITIONS

A. The controller shall be designed and constructed to operate within the following service conditions:

1. Elevation. To 3300 Feet.
2. Ambient Temperature Range. 0°C to 40°C.
3. Atmosphere. Non-Condensing relative humidity to 95 percent.
4. AC Line Voltage Variation. -30 percent to +10 percent.
5. AC Line Frequency Variation. 3 Hertz.
6. Output Frequency. Shall be able to operate at the rated motor horsepower up to 90 hertz without damage to the VFD.

2.7 ENCLOSURE

A. VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-12 enclosure. Enclosure shall be UL listed as a plenum rated VFD.

B. Finish. Apply a finish to enclosure cabinet, trim, and doors. Exterior and interior metal surfaces shall be cleaned and finished with electrostatically applied "powder coat" thermoset enamel baked over a rust-inhibiting phosphatized coating.

2.8 PROTECTIVE FEATURES AND CIRCUITS

A. The controller shall include the following protective features:

1. Single phase fault or 3-phase short circuit on VFD output terminals without damage to any power component.
2. Static instantaneous overcurrent and overvoltage trip with inverse overcurrent protection.
3. Static over speed (over frequency) protection.
4. Line loss and undervoltage protection.
5. Power unit overtemperature protection.
7. Responsive action to motor winding temperature detectors or thermostatic switches.
8. Isolated operator controls.
10. Be insensitive to incoming power phase sequence.
11. Have desaturation circuit to drive inverter section transistor base current to zero in event of controller fault.

12. Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.

13. Input line noise suppression with line reactor.


2.9 PARAMETER SETTINGS

A. The following system configuring settings shall be provided, without exception, field adjustable through the keypad/display unit or via the serial communication port only.

B. Motor Nameplate Data:
   1. Motor frequency.
   2. Number of poles.
   3. Full load speed.
   5. Motor full load amps (FLA).
   6. Motor KW.
   7. Current minimum.

C. VFD Limits:
   1. Independent accel/decel rates.
   2. No load boost.
   3. Vmin, Vmax, V/Hz.
   4. Full load boost.
   5. Overload trip curve select (Inverse or Constant).
   6. Min/Max speed (frequency).
   7. Auto reset for load or voltage trip select.
   8. Slip compensation.
   10. Overload trip time set.

D. VFD Parameters:
1. Voltage loop gain.
2. Voltage loop stability.

E. Controller Adjustments:
1. PID control enable/disable.
2. Setpoint select.
3. Proportional band select.
4. Reset time select.
5. Rate time select.
6. Input signal scaling.
7. Input signal select (4-20mA).
9. Speed Profile: Entry, Exit, Point Select.
10. Min, Max Speed Select.
11. Inverse profile select (allows VFD speed to vary directly or inversely with input signal.)

2.10 DIAGNOSTIC FEATURES AND FAULT HANDLING

A. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions. Microprocessor systems must be products of the same manufacturer as the VFD (to assure single source responsibility, availability of service and access to spare parts).

B. A "FAULT LOG" shall record, store, display and print upon demand, the following for the 3 most recent events:
1. VFD mode (Auto/Manual).
2. Date and Time stamped for each fault
3. Elapsed time (since previous fault).
4. Type of fault.
5. Reset mode (Auto/Manual).

C. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2.7 M/Sec. intervals for the 10 intervals immediately preceding a fault trip:
1. VFD mode (manual/auto/inhibited/tripped/etc.).
2. Speed demand.
3. VFD output frequency.
4. Drive inhibit (On/Off).
5. Feedback (motor) Amps.
6. VFD output voltage.
7. Type of fault:
   a. Inverter O/Temp.
   b. Over Voltage.
   c. Detection Error.
   d. Earth Leakage.
   e. Watchdog.
   f. PSU Power Fail.
   g. Manual Test.
   h. Out of Sat 1-6.
   i. Software Fault.
   j. Waveform Gen.
   k. Remote Watchdog.
   l. Thermistor.
   m. Sustained O/L.
   n. Bypass SCR Trip.

D. The fault log record shall be accessible via a RS485 serial link as well as line by line on the keypad display.

2.11 SYSTEM OPERATION

A. With the H-O-A switch in the "HAND" position, the drive shall be controlled by the manual speed potentiometer on the drive door.

B. With the H-O-A switch in "AUTOMATIC", the drive shall start remotely through the EMS and its speed shall be controlled by a 4-20mA, internally isolated signal from the local Powers Control Panel.

C. With the H-O-A switch in the "OFF" position, the run circuit will be open and the VFD will not operate.

2.12 QUALITY ASSURANCE AND FACTORY TESTS

A. The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:
1. Power transistors, SCR's and diodes shall be tested to ensure correct function and highest reliability.

2. Controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

B. Manufacture of VFD shall certify in shop drawings that VFD and equipment motors are compatible. Contractor shall provide VFD manufacturer complete motor data prior to submittal of shop drawings.

C. Manufacturer shall provide a 3 year warranty on parts and labor to owner for each VFD from date of acceptance by Owner.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the provisions of Section 23 00 00.

B. Deliver products on site in factory fabricated protective containers, with factory installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place, elevated above grade, and protected from weather, sunlight, dirt, moisture, corrosion, and construction traffic.

D. Handle carefully to avoid damage to components, enclosures, and finish. Use only lifting eyes and brackets provided for that purpose. Damaged products shall be rejected and shall not be installed on the project.

E. The manufacturer's representative shall provide a list of recommended spare parts.

F. The manufacturer's representative shall provide terminal block to terminal block wiring diagrams coordinated with the owner to provide a complete and functional operating system. Furnish detailed drawings showing construction, dimensions, wiring diagrams and installation procedures for engineer's approval.

G. As part of the purchase price and agreement, a full, unconditional, one (1) year warranty on all parts and labor shall be provided. The warranty shall include all parts, labor, shipping, field service or technician time, labor or travel expenses and verbal or written correspondence with the VFD manufacturer or his representatives, including that which might be incidental to the proper installation and operation of the equipment.

3.2 PREPARATION

A. Verify that surfaces are ready to receive Work.

B. Verify that field measurements are as shown on Shop Drawings and as instructed by manufacturer.

C. Verify that required utilities are available, in the proper location, and ready for use.

3.3 INSTALLATION

A. Install VFD in accordance with manufacturer’s published, printed instructions.
B. Mounting: VFD’s shall be wall hung units. Contractor shall provide Unistrut mounting bracket for drives. Contractor shall reinforce the wall studs with bracing as required to adequately support the drive. Installation of the VFD shall allow for clearance in front of the drive as required by the latest revision of the National Electric Code for an electrical panel.

1. Mount VFD on Unistrut frame anchored to 4-inch thick concrete pad. Do not mount VFD on wall.

2. Height. In general, mount units so that operating handle is approximately 60 inches above finished floor. Where grouped, align tops of units.

3. Ensure that proper clearance is provided for enclosure as required per NEC Table 110.26(A)(1) for working clearance and dedicated equipment space. Ensure that proper clearance is provided for enclosure as required by manufacturer for proper cooling of VFD.

C. Coordinate with Division 26 to complete raceway, power wiring, and grounding in accordance with the requirements of the NEC and the recommendations of the VFD manufacturer as outlined in the installation manual.

D. Contractor shall verify the existence and proper installation and operation of auxiliary contact on all disconnects located between the load and the drive. Auxiliary contact shall command the VFD to shut down as required to protect the VFD from damage. Any disconnects found lacking this function shall be corrected prior to the startup of the equipment.

E. Interface:

1. Controls. Coordinate with the controls supplier to accomplish proper interface with the building automation system (BAS) direct digital controls (DDC). Refer to Division 23 for Direct Digital Controls.

2. Fire Alarm. Coordinate with Division 28 and the fire alarm supplier to accomplish proper interface with the fire alarm system, as indicated on the Drawings. Refer to Division 28, Fire Alarm System.

3. Shutdown. Coordinate with other divisions to accomplish proper interface for shutdown of VFD, as indicated on the Drawings and as specified in the construction documents.

F. Immediately prior to final acceptance, replace all air filters in VFD.

G. Manufacturer shall provide start-up services and training as follows:

1. Start-up for Contractor to verify correct installation and proper operation.

2. Start-up for Controls Vendor to verify that VFD correctly responds to control command functions and provides alarm condition to control center.

3. Provide minimum two-day training, four (4) hours per day for up to twelve (12) people. The course shall be classroom instruction complete with visual aids, documentation, circuit diagrams and hands-on training. This course shall not be construed as a sales meeting, but rather as a school to familiarize the Owner with the care, troubleshooting, and servicing of the VFD.

END OF SECTION 23 29 23
SECTION 26 00 00
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDED

A. General Requirements specifically applicable to Division 26.

B. The Contractor shall be responsible for:

1. The work included consists of furnishing all materials, supplies, equipment and tools, and performing all labor and services necessary for installation of a completely functional power, lighting, fire alarm and signaling systems. Complete systems in accordance with the intent of Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions, which affect the work covered under this Division.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

4. Temporary power service and lighting for construction. Coordinating all shutdown dates and schedules with Owner's Representative and obtain all work-permits required by Owner.

C. Intent of Drawings:

1. The Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every device or raceway in its exact location, unless specifically dimensioned. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceway, subject to prior review by the Owner and Engineer. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

2. The intent of the Drawings is to establish the type of systems and functions, but not to set forth each item essential to the functioning of the system. The drawings and specifications are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Review pertinent drawings and adjust the work to conditions shown. In case of doubt as to work intended, or here discrepancies occur between drawings, specifications, and actual conditions, immediately notify the Architect/Engineer and the Owner's representative, and propose a resolution.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project electrical systems and equipment.

1. Division 01 Sections included in the project specifications.

2. The contract.

1.3 DESIGN CRITERIA
A. Equipment and devices to be installed outdoors or in enclosures where the temperatures are not controlled shall be capable of continuous operation under such conditions per manufacturer’s requirements.

B. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.

C. Electrical components shall be UL listed and labeled.

1.4 REFERENCE CODES AND STANDARDS, REGULATORY REQUIREMENTS

A. Standards of the following organizations as well as those listed in Division 01, may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

1. Association of Edison Illuminating Companies (AEIC)
2. American National Standards Institute (ANSI)
3. Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. National Electrical Code (NEC)
6. National Electrical Manufacturers Association (NEMA)
7. Electrical Safety in the Workplace
8. National Fire Protection Association (NFPA)
9. Underwriter’s Laboratories (UL)

B. Work, materials and equipment must comply with the latest rules and regulations of the following.

1. National Electrical Code (NEC)
2. Electrical Safety in the Workplace
3. Occupational Safety and Health Act (OSHA)
4. American with Disability Act (ADA)
5. American Society for Testing and Materials (ASTM)
6. University of Texas (UT) System
7. Applicable state and federal codes, ordinances and regulations

C. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner’s representative in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified shown.

D. Contractor shall obtain permits and arrange inspections required by codes applicable to this Section and shall submit written evidence to the Owner and Engineer that the required permits, inspections and code requirements have been secured.

1.5 SUBMITTALS
A. Submit the following in addition to and in accordance with the requirements of Division 01 for submittal requirement.

1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.

2. Manufacturer’s standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of it are clearly indicated and non-applicable portions clearly deleted or crossed out.

3. All schematic, connection and/or interconnection diagrams in accordance with the latest edition of NEMA.

4. Provide submittals as required by individual specification Section.

B. Provide the following with each submittal:

1. Catalog cuts with manufacturer’s name clearly indicated. Applicable portions shall be circled and non-applicable portions shall be crossed out.

2. Line-by-line specification review by equipment manufacturer and contractor with any exceptions explicitly defined.

C. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads should be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.

D. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.

1. Itemize equipment and material by specification Section number; include manufacturer and identifying model or catalog numbers.

2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.

3. If a satisfactory replacement is not submitted within a two-week period, owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to owner.

E. As-Built Record Drawings: The Contractor shall maintain a master set of As-Built Record Drawings that show changes and any other deviations from the drawings. The markups must be made as the changes are done. At the conclusion of the job, these As-Built Record Drawings shall be transferred to AutoCad electronic files, in a format acceptable to the Owner, and shall be complete and delivered to the Owner's Representative prior to final acceptance. Refer to 01210 Project Administration for other requirements.

1.6 SAFETY

A. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of Project Safety Manual (PSM).

1. The Contractors shall be responsible for training all personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.

2. The Contractor shall secure all electrical rooms, to limit access, prior to energizing any high voltage (2.4KV or higher) switchgear and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is on going near energized equipment. The Contractor shall cover all energized live parts when work is not being done in the equipment. This
includes lunch and breaks.

3. The Contractor shall strictly enforce OSHA lock out/tag out procedures. Initial infractions shall result in a warning; a second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

1.7 SHORING AND EQUIPMENT SUPPORTS

A. The Contractor shall provide all permanent and temporary shoring, anchoring, and bracing required to make all parts absolutely stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.

B. The Contractor shall adequately support all freestanding panels, motor control centers, enclosures, and other equipment. This shall include bolting to the floor or solid structural steel to prevent tipping. Install free-standing electrical equipment on 4” thick concrete housekeeping pads that are provided by others. Under no condition shall equipment be fastened to non-rigid building steel (i.e., removable platform steel gratings, handrails, etc.).

C. The Contractor shall provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. At no time shall the Contractor mount or suspend equipment from other disciplines’ supports.

1.8 TEMPORARY POWER REQUIREMENTS

A. Provide power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15 and 20 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.

B. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.

C. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate equipment grounding conductor.

D. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.

E. Provide temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels and submit plan for approval by the owner.

F. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.

G. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.
1.9 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

A. Refer to Uniform General Conditions and Supplementary General Conditions for substitution of materials and equipment.

B. The intent of the Drawings and/or Specifications is neither to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

C. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.

D. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

E. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

F. All equipment installed on this project shall have local representation; local factory authorized service, and a local stock of repair parts.

G. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

H. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

I. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

J. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.
PART 2      PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Materials shall be of a standard industrial quality if no specifications or specific model numbers are given.

B. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

C. All materials shall be new and unused.

D. Provide non-metallic material in corrosive areas or as otherwise specified.

PART 3      EXECUTION

3.1 WORKMANSHIP

A. Install work in compliance with NEC latest edition.

B. Install material and equipment in accordance with manufacturers’ instructions. Provide calibrated torque wrenches and screwdrivers and tighten all terminals, lugs, and bus joints using it.

C. Comply with startup procedures as defined by Construction Manager and Owner.

D. Arrange electrical work in a neat, well-organized manner. Do not block future connection points of electrical service. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.

E. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.

F. Make opening through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.

3.2 SERVICE CONTINUITY

A. Maintain continuity of electric service to all functioning portions of process or buildings during the hours of normal use. Phase construction work to accommodate Owner’s occupancy requirements.

B. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.

C. All service outages shall be requested in writing a minimum of two weeks prior to the date. Owner reserves the right to postpone shutdowns up to 24 hours prior to the shutdown at no additional cost. Outage requests shall include a schedule of the work to be performed and the time requirements.

D. The Contractor shall obtain all appropriate Owner permits for working in equipment.

3.3 HAZARDOUS LOCATIONS

A. Equipment, wiring, devices, and other components located within hazardous areas to be of appropriate type per NFPA requirements.

B. Ground exposed non-current carrying parts of entire electrical system in hazardous areas, in accordance with NEC and as instructed by Owner.

3.4 SLEEVES AND SEALS
A. Provide sealing and/or fire stopping where electrical equipment passes through walls, ceilings, and floors. Seals shall be watertight and/or fire rated as applicable.

3.5 CONSTRUCTION REVIEW

A. The Engineer or Owner’s representative will review and observe installation work to insure compliance by the Contractor with requirements of the Contract Documents.

B. Review, observation, assistance, and actions by the Engineer or Owner’s representative shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The review and observation activities shall not relieve the Contractor from the responsibilities of these Contract Documents.

C. The fact that the Engineer or Owner’s representative do not make early discovery of faulty or omitted work shall not bar the Engineer or Owner’s representative from subsequently rejecting this work and insisting that the Contractor make the necessary corrections.

D. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the Engineer or Owner’s representative for an increase in the Contract price, or for any payment on account of increased cost, damage, or loss.

3.6 WARRANTY

A. Provide warranties in accordance with the requirements of Uniform General and Supplementary Conditions (UGC).

END OF SECTION
SECTION 26 00 00.01
ELECTRICAL DEMOLITION

PART 1 -- GENERAL
1.1 WORK INCLUDED
   A. Electrical demolition for remodeling.
   B. Electrical/control portion of HVAC work covered by Division 23 pertaining electrical demolition shall follow the requirement set forth by this specification.

1.2 RELATED WORK
   A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for minor electrical demolition for remodeling.
      1. Section 26 00 00 - Basic Electrical Requirements.
   B. In the event of conflict regarding minor electrical demolition requirements between this Section and any other Section, the provisions of this Section shall govern.

PART 2 -- PRODUCTS
2.1 MATERIALS AND EQUIPMENT
   A. Materials and equipment for patching and extending work: as specified in individual Sections.
   B. Provide all materials necessary for work.

PART 3 -- EXECUTION
3.1 EXAMINATION
   A. All demolitions or modifications to existing systems shall be coordinated through Owner’s Representative. Demolition drawings are based on casual field observation and existing record documentations. Therefore the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and circuiting arrangements are as shown on Drawings and abandoned wiring and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to Engineer before disturbing existing installation.
   B. Beginning of demolition means Contractor accepts existing conditions.

3.2 PREPARATION
   A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal. Provide temporary wiring and connections to maintain remaining systems in service during demolition and/or modification. Owner reserve the right up to 24 hours prior to any scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.
   B. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. No work shall begin without proper permits and authorizations. Disable system only to make switchovers and connections. Obtain permission from Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
C. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Provisions for manual fire watch shall be provided in areas where services are interrupted. Make temporary connections to maintain service in areas adjacent to work area.

D. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Notify Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new plan drawings.

B. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes full length from source to device. Cut embedded or concealed conduit flush with walls and floors, and patch surfaces.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

D. Disconnect and remove abandoned panelboards and distribution equipment.

E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

G. Repair adjacent construction and finishes damaged during demolition and extension work.

H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

I. Extend existing installations using materials and methods compatible with existing electrical installation or as specified.

J. The level of completion shall be demonstrated to Owner’s Representative.

K. Where equipment is indicated to be demolished and returned to Owner, the Contractor shall include the delivery of this equipment to the Owner’s site storage area. Remove with care all equipment to be relocated. Repair or replace of newly damaged equipment is the responsibility of the Contractor.

3.4 CLEANING AND REPAIR

A. The Contractor shall follow Owner’s clean work policy and shall include the removal of trash and demolished material from the building or work area at the end of each day and removal from the site once a week.

B. The Contractor shall be responsible for repairing adjacent construction and finishes damaged during demolition and/or modification. The Contractor shall be responsible for the removal of ceiling tiles required in the demolition work. The Contractor shall be responsible for the replacement of damaged tiles and reinstallation of the ceiling prior to final acceptance.

C. 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.
D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.

3.5 DISPOSITION OF MATERIAL AND EQUIPMENT

A. Review with the Owner materials that have been removed and are no longer required, to determine any which the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner’s specified location.

B. For those materials not required by the Owner, dispose of them in accordance with applicable regulations.

END OF SECTION
PART 1 GENERAL

1.1 WORK INCLUDED

A. Hinged cover enclosures and cabinets
B. Contactors
C. Control relays
D. Push buttons, and selector switches
E. Terminal blocks and accessories
F. Penetration sealing systems (fire stops)
G. Electrical/control portion of HVAC work covered by Division 23 pertaining basic electrical materials and methods shall follow the requirement set forth by this specification.

1.2 APPLICABLE CODES AND STANDARDS

A. NFPA 70, National Electrical Code (latest edition)
C. Applicable publications of NEMA, ANSI, IEEE, and ICEA
D. Underwriters Laboratories, Inc. Standards (UL)
E. Federal, city, state, and local codes and regulations having jurisdiction
F. OSHA requirements
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
H. NEMA WD 1 – General-Purpose Wiring Devices
I. UL 98 - Enclosed Switches

1.3 INTENT

A. This Section is not, and shall not be interpreted to be, a complete listing of all materials or equipment that is Contractor furnished and erected. It is intended to clarify and further define the Contractor scope of work, procurement, and responsibilities for those incidental materials that are not specified by other specifications, but important to a complete and operational system.

B. The Contractor shall furnish all equipment and materials, whether or not specified in other Sections of specification and on drawings, for installation and connection required to place equipment into satisfactory operating service. The Contractor shall review the Drawings and specifications for clarification of his responsibility in the handling and installation of equipment and material. Where applicable, and not in contradiction with the Drawings and specifications, the Contractor shall install and connect the equipment in accordance with the manufacturer's recommendations and instructions.

C. All materials and equipment shall be of types and manufacturer specified wherever practical. Should materials or equipment so specified be unattainable, the Contractor shall submit the description and manufacturer's literature, reason for substitution request and shall secure the approval of the Engineer before substitution of other material or equipment is purchased. This Section establishes performance requirements and the quality of
equipment acceptable for use and shall in no way be construed to limit procurement from other manufacturer.

1.4 SUBMITTALS
A. Provide submittals in addition and in accordance with Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 for submittal requirement.
B. Submit manufacturer's literature and specification data sheets for each type of basic material, which is applicable to the project.

1.5 DELIVERY, STORAGE AND HANDLING
A. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit. Damaged materials shall be removed from project site.
B. In their factory-furnished coverings, store materials in a clean, dry indoor space, which provides protection against the weather.

PART 2 PRODUCTS
2.1 ENCLOSURES AND CABINETS
A. Enclosures and cabinets for all Contractor furnished electrical equipment and devices shall be suitable for the location and environmental conditions and shall be of the NEMA type as shown in Table 16050-1. Exceptions shall be specifically designated on the Drawings.

<table>
<thead>
<tr>
<th>Location</th>
<th>Environment</th>
<th>Enclosure Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Utility</td>
<td>Dry, subject to dust, falling dirt and dripping non-corrosive liquids</td>
<td>NEMA 12</td>
</tr>
<tr>
<td>Indoor</td>
<td>Clean, Dry</td>
<td>NEMA 1</td>
</tr>
<tr>
<td>Outdoor</td>
<td>Subject to windblown dust and rain, splashing water, and hose-directed water</td>
<td>NEMA 4</td>
</tr>
<tr>
<td>Indoor</td>
<td>Wet, subject to hose-directed water</td>
<td>NEMA 4</td>
</tr>
<tr>
<td>Outdoor</td>
<td>Subject to falling rain, sleet, and external ice formation</td>
<td>NEMA 3R</td>
</tr>
<tr>
<td>Indoor or Outdoor</td>
<td>Subject to corrosion, windblown dust and rain, splashing water and hose-directed water</td>
<td>NEMA 4X</td>
</tr>
</tbody>
</table>

B. Enclosures shall have the following properties:
      a. Type 1: Steel.
      b. Type 4: Steel with gasket door, rain tight.
      c. Type 4X: Stainless steel, (polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas).
d. Type 12: Steel with gasketed door, dust-tight.

C. Finish: Exterior, manufacturer's standard gray enamel finish; interior, white enamel finish.

D. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock. Where required for NEMA ratings, gaskets shall be neoprene rubber.

E. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.

F. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

G. Forced Ventilation: Where indicated, provide 115V single-phase fan motor, filtered with air plenum, finger guard, and stainless steel grille. Washable aluminum filter, accessible for cleaning from outside the enclosure; 20,000-hour continuous operation without lubrication or service. Provide matching exhaust grille assembly. Mount fan in lower side corner, exhaust grille in opposite upper side corner.

2.2 CONTACTORS

A. Acceptable Manufacturers

1. General Electric Company
2. Square D Company
3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00.UT and Division 01 for substitution requirement.

B. Contactors: NEMA ICS 2; electrically held or mechanically held as indicated on Drawings. Two-wire control for electrically held contactors and three-wire control for mechanically held contactors.

C. Enclosure: NEMA 1 unless indicated otherwise on Drawings.

D. Control Transformer: Provide when indicated on Drawings. Minimum capacity shall be 100 VA. Provide primary and secondary fuse protection.

E. Coil operating voltage; 110 volts, 60 Hz or as per drawings.

F. Size: NEMA ICS 2; size as indicated on Drawings.

G. Contacts: As indicated on Drawings; 600 Volts, 60 Hz.

H. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

2.3 CONTROL RELAYS

A. Acceptable Manufacturers

1. General Electric Type CR120A
2. Cutler-Hammer Type M-300
3. Square D Company
4. Allen-Bradley
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00.UT and Division 01 for substitution requirement.
B. Provide magnetic control relays, NEMA Class A: A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.

C. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a solid-state timer attachment adjustable from 0.2 to 60 seconds (minimum) or with range as indicated. Provide with field convertible from ON delay to OFF delay and vice versa.

D. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

2.4 PUSH BUTTONS, AND SELECTOR SWITCHES

A. Acceptable Manufacturers
   1. Allen-Bradley
   2. Square D
   3. Cutler Hammer
   4. Seimens
   5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 UT and Division 01 for substitution requirement.

B. For non-hazardous, indoor, dry locations, including control panels, and individual stations, provide heavy duty, NEMA 13, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices.

C. For non hazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, NEMA 4, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4 watertight enclosures. Provide special gasketing required to make complete station watertight.

D. For hazardous locations, provide control station listed by UL for Class I, Divisions 01 and 02, Groups C and D; Class II, Division 01 and 02, Groups E, F, and G. Specific type shall be in accordance with area classification as indicated on the Drawings.

E. For corrosive locations, provide nonmetallic components and enclosures meeting NEMA Type 4X.

F. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide push-button stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Nameplates shall be as specified in Section 16195.

G. Utilize selector switches having standard operating levers. All indicating lights shall be LED type, push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.5 TERMINAL BLOCKS AND ACCESSORIES

A. Signal And Control Terminals
   1. Acceptable Manufacturers
      a. Phoenix Contact
b. Buchanan

c. Weidmüller

d. Entrelec

e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 23 00 00 and Division 01 for substitution requirement.

2. Signal and Control Terminals: Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24-inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.

B. Power Terminals

1. Acceptable Manufacturers

   a. Buchanan

   b. Ilsco

   c. Square D Company

   d. Burndy

   e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

2. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals.

2.6 PENETRATION SEALING SYSTEMS (FIRE STOPS)

A. Provide penetration sealing where conduit, cable tray, etc. pass through rated walls, ceilings, and floors. See Section 07840, Fire Stopping, and Section 07900, Joint Sealants, for sealing requirements and systems.

2.7 UL LISTING

A. All equipment and materials shall be new and conform to the requirements of this Section. All equipment and materials shall be UL listed, and shall bear their label whenever standards have been established and level service is regularly furnished. All equipment and materials shall be of the best grade of their respective kind for the purpose.

PART 3 EXECUTION

3.1 FABRICATION - CONTROL ENCLOSURES AND CABINETS

A. Shop assembles enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

3.2 INSTALLATION - ENCLOSURES AND CABINETS

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.

   B. Provide accessory feet for freestanding equipment enclosures.
C. Install trim plumb.

3.3 ERECTION OF EQUIPMENT

A. Manufacturer’s Installation Instructions: Where furnished or called for by the manufacturer, equipment manufacturer’s installation instructions shall be considered a part of this specification and fully complied with. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.

B. Mounting Heights: Individual safety switches and buttons and devices shall normally be installed at the following mounting heights, when not specified on the Drawings.
   1. Safety Switches: 6 feet 0 inches (to top).
   2. Pushbuttons: 4 feet 0 inches (to center).
   3. Control Panels: 6 feet 0 inches (to top).

C. Mounting: Equipment and control devices shall be supported independent of conduit connections. Panels or cabinets shall be mounted on metal frame supports independently of equipment. Control devices and metal enclosures shall be bolted or welded to steel channel or steel plate. All electrical equipment and devices not covered by the above, such as miscellaneous switches, thermostats, duct switches, temperature switches, floats, photoelectrical devices, and similar electrical devices shall be located and set as suitable for the application. Where control panels are provided as part of the equipment racks mounted on the floor, they shall be provided to support conduits and flexible connections to control panels.

3.4 COORDINATION

A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified by Engineer's field representative prior to installation.

END OF SECTION
SECTION 26 05 19
CABLE, WIRE AND CONNECTORS, 600 VOLT

PART 1 GENERAL

1.1 WORK INCLUDED
A. Building wire.
   1. Power distribution circuitry.
   2. Control system circuitry.
   3. Lighting circuitry.
   4. Appliance and equipment circuitry.
   5. Motor-branch circuitry.
   6. Outdoors lighting and power.
   7. Other systems circuitry as designated.
B. Cable.
C. Wiring connections and terminations.
D. Electrical/control portion of HVAC work covered by Division 23 pertaining 600 volt cable, wire and connectors shall follow the requirement set forth by this specification.

1.2 REFERENCES
A. NEMA WC 3 - Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
B. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
C. ANSI/UL 83 – Thermoplastic-Insulated Wire and Cables
D. NFPA 70 – National Electrical Code, latest edition
F. Where application of National Electrical Code, trade association standards or publications appears to be in conflict with the requirements of this Section, the Architect/Engineer shall be asked for an interpretation.

1.3 SUBMITTALS
A. Provide submittals in accordance with and in additional to Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 for submittal requirement.
B. Submit manufacturer's literature and specification data sheets for each item of cable, wire connectors.
C. Qualification of cable and wire manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years experience.

1.4 DELIVERY, STORAGE AND HANDLING
A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory
packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from project site.

B. Store cable, wire and connectors in a clean, dry indoor space in their factory-furnished coverings, which provides protection against the weather.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Generally, cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information.

B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper with insulation as noted below. Minimum size for control shall be #14 copper.

C. The conductors of wires and cables shall be of copper (tinned where specified), and have conductivity in accordance with the standardization rules of the IEEE. The conductor and each strand shall be round and free of kinks and defects.

D. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.

E. All cable specified for use in tray shall be multiconductor and shall have an outer jacket of flame-retardant, moisture and sunlight resistant polyvinyl chloride (PVC) and shall be UL and NEC approved type for tray installation. Cable installed in cable tray outdoors shall have a jacket that is UV resistant chlorinated polyethylene (CPE) or polyvinyl chloride (PVC), rated 90°C per UL Standard 1277.

F. All low voltage power and control cable installed in open cable tray above ceilings used for return air shall be plenum rated. Where tray cable is not available in size and type required, conductors shall be installed in conduit.

G. Use compression lugs for all wiring terminations, except on breakers or terminal strips in panel boards.

2.2 BUILDING WIRE

A. Thermoplastic-insulated Building Wire: NEMA WC 5.


C. Feeders and Branch Circuits Larger Than 10 AWG: 98% conductivity copper, soft-drawn, stranded conductor, 600 volt insulation, THHN/THWN Use XHHW conductors where installed in conduit underground.

D. Feeders and Branch Circuits 10 AWG and Smaller: 98% conductivity copper, soft-drawn, stranded conductor, 600-volt insulation, THW/THHN/THWN.

2.4 WIRING CONNECTIONS AND TERMINATIONS

A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. Select from only following types, classes, kinds and styles.

1. Type:
a. Solderless pressure connectors  
b. Crimp.  
c. Threaded.  
d. Insulated spring wire connectors with plastic caps for 10 AWG and smaller.

2. Class: Insulated.

3. Material: Copper (for CU to CU connection).

4. Style:
   a. Insulated terminals. Use ring-terminal for control wiring. Use flange (fork) spade compression terminal for termination of stranded conductors at wiring devices, including ground connection.
   b. Split bolt-parallel connector.
   c. Pigtail connector.
   d. Pre-insulated multi-tap connector.

PART 3 EXECUTION

3.1 INSPECTION

A. Installer must examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 GENERAL WIRING METHODS

A. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.

B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Do not install the conductors until raceway system is complete and properly cleaned.

C. Cables shall be selected on the basis of their purpose and UL listing. Generally, use Types THWN and THHN in building interiors and other dry locations. Outdoors and underground in raceways, use Type RHW. Conductors subject to abrasion, such as in lighting poles, shall be Type THWN or THHN.

D. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 50' in length (100' for 277 volt) no conductor smaller than a No. 10 wire shall be used. The sizing of all wire except remote control wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions. Separate neutral conductors shall be provided for each phase of the same size for 120V/277V single-phase application for heavy electrical loads, computer loads, loads fed from isolated transformers, lab equipment, clinic equipment, dedicated circuits, unless noted otherwise on drawings. Voltage drop on feeders and branch circuits shall not exceed NEC requirement.

F. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.
G. Splice branch circuits only in accessible junction or outlet boxes. Control cable shall never be spliced except the final connection to field devices. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.

H. Wiring Within An Enclosure: Contractor shall bundle ac and dc wiring separately within an enclosure. The Contractor shall utilize panel wire-ways when they are provided. Where wireways are not provided the Contractor shall neatly tag, bundle wires and secure to sub-panel at a minimum of every three inches with T&B Type TC5355 heavy duty mounting bases.

I. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

3.3 WIRING INSTALLATION IN RACEWAYS

A. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Pull conductors together where more than one is being installed in a raceway.

C. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

D. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.

E. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

F. Place an equal number of conductors for each phase of a circuit in same raceway.

G. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.

H. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

3.5 WIRING CONNECTIONS AND TERMINATIONS

A. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

B. Keep conductor splices and taps accessible and to a minimum, and in junction boxes only. Control circuit conductors shall terminate at terminal blocks only. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotchcast.

C. Use splice, tap and termination connectors, which are compatible with the conductor material.

D. Thoroughly clean wires before installing lugs and connectors.

E. Terminate spare conductors with electrical tape and label as spare.

F. Power and Lighting Circuits: Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.
G. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

H. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then two layers of No. 33 half-lapped.

I. Identify conductors per Section 26 05 53 - Electrical Identification.

3.6 FIELD QUALITY CONTROL

A. Torque test conductor connections and terminations to manufacturer's recommended values.

B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

C. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

D. Conductors may be run in parallel on sizes 1/0 to 500 MCM inclusive provided all paralleled conductors are the same size, length, and type of insulation. Except as otherwise shown on drawings, no more than three conductors may be run in parallel, and they shall be so arranged and terminated as to insure equal division of the total current between all conductors involved. Where parallel connection is contemplated, approval of the Owner's representative must be obtained before installation is made.

3.7 TESTING AND ACCEPTANCE

A. Before final acceptance, the Contractor shall make voltage, insulation, and load tests, necessary to demonstrate to the Owner's representative the satisfactory installation and proper performance of all circuits.

B. Test feeder conductors clear of faults. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems. Test results below 50 megohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductor.

C. At the completion of this project, the Contractor shall provide for the Owner three (3) complete and finally corrected sets of working drawings. These sets of working drawings shall be new, unused and in good condition, and shall include the nature, destination, path, size and type of wire and all other characteristics for complete identification of each and every conduit and circuit.

END OF SECTION
SECTION 26 05 26
GROUNDING

PART 1 -- GENERAL

1.1 WORK INCLUDED
A. Power system grounding.
B. Communication system grounding.
C. Electrical equipment and raceway grounding and bonding.

1.3 REFERENCES
A. NFPA 70 – National Electrical Code, latest edition
B. ANSI/UL 467 – Electrical Grounding and Bonding Equipment
C. ANSI/IEEE STD 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems
D. IEEE 81 – Guide for Measuring Earth Receptivity, Ground Impedance and earth Surface Potential of a ground System
E. IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
F. ANSI/TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

1.4 SYSTEM DESCRIPTION
A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Concrete encased electrodes shall be connected as the most effective grounding electrodes. Provide a completely grounded system in accordance with Article 250 of the NEC.

B. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformer, UPS systems, power conditioners, inverters, or other power supplies are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.

C. Provide communications system grounding conductor connected to separate electrode (ground bus) that is installed in each IT room.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metal underground water pipe.

E. Bonding jumpers shall be installed around non-metal fittings or insulating joints to ensure electrical continuity. Bonding shall be provided where necessary to ensure electrical
continuity and the capacity to conduct safely any fault current likely to be imposed.

G. Use minimum 6 AWG copper conductors for communications service grounding conductor. Leave 10 feet slack conductor at termination board.

1.4 SUBMITTALS
A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 -- PRODUCTS
2.1 MATERIALS AND EQUIPMENT
A. Grounding system components shall be as required to comply with the design and construction of the system indicated. Components shall be as indicated in manufacturer's submittal data.
B. Ground conductors shall be stranded tinned, annealed copper cable of the sizes indicated on drawings. Bond grounding conductors at both ends of metallic conduit.
C. Grounding clips shall be Steel City Type G, or equal.
D. Ground Rods shall be copper-encased steel, 3/4" diameter, minimum length 10 feet.

PART 3 -- EXECUTION
3.1 INSTALLATION
A. Install ground system as indicated, in accordance with the applicable requirements of the National Electrical Code and the National Electrical Contractors Association's "Standard of Installation".
B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Install test wells as required per drawings.
C. In feeder and branch circuits, provide a separate, insulated equipment grounding conductor. Terminate each end on a grounding lug, bus, or bushing.
D. Connect grounding electrode conductors to metal water pipe where metal pipe is available and accessible using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
E. Install fusion welded ground connectors where they are concealed or inaccessible.
F. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate; or by the use of an approved grounding yoke type receptacle.
G. No strap grounding clamps shall be used; connections requiring bolting shall be made up with monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.
H. Install external ground wire on liquid tight flexible metal conduit with grounding bushings.
I. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors.
J. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device.
K. Connect grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection points below finished grade. Below grade connection shall be
exothermic-welded type connectors as manufactured by Cadweld, Thermoweld. In manhole, install ground rods with 4 to 6 inches above the floor with connections of grounding conductors fully visible and accessible.

M. Provide grounding and bonding at Utility Company's metering equipment and pad-mounted transformer in accordance with Utility Company's requirements.

3.2 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 10 ohms. Provide additional ground rod as required until resistance reading is 10 ohms or less.

END OF SECTION
PART 1 GENERAL
1.1 WORK INCLUDED
   A. Raceway, cable tray, and equipment supports
   B. Fastening hardware
   C. Coordinate location of concrete equipment pads
1.2 QUALITY ASSURANCE
   A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry. Support systems shall be sized adequately to support an additional 25% for future loads
1.3 COORDINATION
   A. Coordinate with other trades where conduit and cable tray supports are in the same location as piping, ductwork, and work of other trades and where supports are furnished and installed under other Divisions. Supporting from the work or supports of other Contractors shall not be allowed except by express, written permission of the Owner.
1.4 SUBMITTALS
   A. Provide submittals in accordance with and in addition to Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 PRODUCTS
2.1 MATERIAL
   A. Support Channel:
      1. All non-corrosive locations: Hot-dip galvanized steel.
      2. Corrosive locations: Nonmetallic fiberglass.
   B. Hardware:
      1. All non-corrosive locations: Hot-dip galvanized steel.
      2. Corrosive locations: Stainless steel threaded rod, attachments and fasteners shall be used with fiberglass supports.
   C. Threaded Rod: used for rack support from structure above; 3/8-inch minimum diameter.

PART 3 EXECUTION
3.1 INSTALLATION
   A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, or beam clamps. Do not use spring steel clips and clamps. Provide necessary calculations to select proper support materials for electrical equipment, raceway, and cable tray supports. Provide cable tray supports for cable tray filled to 125 percent capacity per NEC.
   B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer’s written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for
installation of supporting devices. Install supports with spacing in compliance with NEC requirements.

C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors in solid masonry walls; or concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

E. Do not use powder actuated anchors without written permission from the Engineer.

F. Do not drill structural steel members without written permission from the Structural Engineer.

G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.

I. Install surface mounted cabinets and panelboards with a minimum of four anchors. Provide strut channel supports to stand cabinet 1-5/8 inches off wall. Utilize “Post Bases” where support channel is attached to structural floor.

J. Provide extra care in supporting PVC conduit to protect it from potential damage.

K. Use fiberglass for nonmetallic raceway systems supports in areas subject to corrosives.

L. All supports in contact with floor using stanchion type support shall be solidly bolted to the permanent structural floor.

M. Conduit supports shall have at a minimum, the bottom support member constructed of double strut. This horizontal member shall be double-nutted, and the supporting all-thread rod shall be trimmed to one inch below lowest nut.

N. Conduit entering/exiting cable tray shall be attached to the tray rail by means of unistrut bolted to the rail and standard manufacturer's accessories. Conduit shall only enter/exit tray horizontally supported within three feet of the tray, and extended into the tray two inches. Conduit shall be terminated with a grounding bushing, and bonded to the tray ground wire. (The attachment to the tray shall not be considered a support.)

O. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

P. Install freestanding electrical equipment on 4-inch concrete pads. Pad shall be a minimum four inches larger than equipment. No crevices shall be left around the pads. Equipment includes but not limited to the following:

1. Motor Control Centers
2. Static Transfer Switches
3. Floor mounted VFDs
4. Floor mounted transformers
5. Switchboards, 1200A and larger

Q. Do not anchor supports to columns. Where panelboards, cables, or conduits are routed on the face of a column provide “column hugging” channel supports.

3.2 TOUCH-UP
A. Touch-up all scratches on securing and supporting system, and paint the ends of channel after cutting with an approved zinc chromate or 90 percent zinc paint.

END OF SECTION
PART 1 GENERAL

1.1 WORK INCLUDED

A. Raceways:
   1. Surface metal raceways.
   2. Multi-outlet assemblies.
   3. Wireways.
   4. Indoor service poles.

B. Conduit:
   1. Rigid metal conduit and fittings. (RGS)
   2. Intermediate metal conduit and fittings. (IMC)
   3. Electrical metallic tubing and fittings. (EMT)
   4. Flexible metal conduit and fittings.
   5. Liquid-tight flexible metal conduit and fittings.
   6. Non-metallic conduit and fittings. (underground use only)
   7. PVC coated rigid steel conduit.

C. Boxes:
   1. Wall and ceiling outlet boxes.
   2. Pull and junction boxes.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining raceway, conduit and boxes shall follow the requirement set forth by this specification.

1.2 REFERENCES

A. NFPA 70 – National Electrical Code, latest edition
B. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
C. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated
B. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies
E. EMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
F. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
H. ANSI/NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
I. ANSI/UL 1 – Flexible Metal Conduit
J. ANSI/UL 5 – Surface Metal Raceways and Fittings
K. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit
L. ANSI/UL 467 – Electrical Grounding and Bonding Equipment
M. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit (underground use only)
N. ANSI/UL 797 – Electrical Metal Tubing
O. ANSI/UL 870 – Wireways, Auxiliary Gutters and Fittings
P. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated galvanized Rigid Steel Conduit and Intermediate Metal Conduit
Q. NEMA VE 1 – Metallic Cable Tray Systems
R. UL 6 – Rigid Metal Conduit
S. ANSI/UL 5C – Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits
T. ANSI/UL 498 – Attachment Plugs and Receptacles
U. ANSI/UL 943 – Ground Fault Circuit Interrupters

1.3 SUBMITTALS
A. Provide submittals in accordance with and in addition to Section 26 00 00.UT, Basic Electrical Requirements, and Section 01330, Submittal Procedures.
B. Shop drawings consisting of a complete list of equipment and materials, which will be used for the project, including manufacturer's descriptive and technical literature, catalog cuts and installation instructions.
C. Sealing/fire stopping materials and details.

1.4 STORAGE AND HANDLING
A. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.
B. Store materials in a clean dry space and protected from the weather.

PART 2 PRODUCTS

2.1 SURFACE METAL RACEWAY
A. Surface metal raceway shall be factory pre-assembled galvanized steel complete including bases, removable covers, receptacles, end plates, elbows, connectors and fittings, to exact length to match the length of the cabinets, casework, utility chases, and shelving as indicated on laboratory and furniture shop drawings, and work bench details, as applicable.
B. Size shall be as shown on the Drawings. The length shown on electrical drawings is diagrammatic only and is not accurate for fabrication of raceway Sections. Refer to shop drawings, architectural plans, elevations, and details.
C. Finish shall be ANSI-61 gray enamel.
D. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.
E. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system per drawing as applicable. Provide divider with fittings that maintain the separation of the raceway wiring compartments.
F. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates.
2.3 WIREWAYS

A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.

B. Size shall be as indicated on Drawings.

C. Cover shall be hinged or screw applied as indicated on Drawings. Rain tight wireways shall be provided with full gasketing.

D. Fittings shall be so constructed to continue the "lay-in" feature through the entire installation.

E. Provide all sheet metal parts with a rust inhibiting phosphatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

2.4 CONDUIT AND FITTINGS

A. Conduit and fittings for all electrical systems on this project shall include the following:
   1. Service entrance
   2. Electrical power and lighting feeders
   3. Electrical power and lighting circuits
   4. Telephone systems
   5. Control systems (other than HVAC)
   6. Fire alarm and signaling systems
   7. CCTV rough-in system
   8. Clock and bell system
   9. Computer system rough-in
   10. Sound system rough-in
   11. Other electrical systems

B. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.

C. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by N.E.C. Article 250. Grounding bushings shall have insulated throats.

D. Rigid and intermediate metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type. Expansion fittings shall be OZ Type DX.

E. Electrical metallic tubing shall be galvanized. Fittings shall be all steel compression type. Expansion fittings shall be OZ Type TX.

F. Flexible metal conduit and fittings shall be zinc-coated steel.

G. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC). It shall be...
furnished with a sealing O-ring where entering an enclosure subject to moisture. Where O-Rings are used, ground type bushings shall be used in the box or enclosure.

H. Nonmetallic conduit and fittings shall be suitable for temperature rating of conductor but not less than 90°C. Nonmetallic conduit and fittings shall be molded of high impact PVC compound having noncombustible, nonmagnetic, non-corrosive and chemical resistant properties and shall be of the same manufacturer. Where located outdoors and above ground, the conduit and fittings shall be UV resistant. Solvent cement shall be of the same manufacturer as the conduit and shall be of the brush-on type. Spray solvents are prohibited. PVC coated metallic fittings shall not be permitted for PVC conduit connections.

I. Crimp or set-screw type fittings are not acceptable.

J. Minimum conduit size shall be 3/4 inch, except 1/2 inch flexible metallic conduit may be used as fixture whips.

K. PVC coated rigid steel conduit shall be externally coated with a 40 mil PVC coating and internal phenolic coating over a galvanized surface.

2.5 WALL AND CEILING OUTLET BOXES

A. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

1. Outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

2. Provide multi-gang outlets of single box design. Sectional boxes are not acceptable. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NEC, and not less than 1 ½ inch deep unless shallower boxes are required by structural conditions and are approved by the A/E.

B. Provide deep type cast metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and fasteners. Provide PVC type outlet boxes only in corrosive areas rated as NEMA 13X.

C. Outlet boxes in poured concrete shall be plenum type without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

D. Provide 4-inch octagonal ceiling outlet boxes.

2.6 PULL AND JUNCTION BOXES

A. Boxes shall be galvanized sheet metal conforming to ANSI/NEMA OS 1 with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.

B. Boxes larger than 12 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.

C. Boxes shall be sized in accordance with NEC.

D. Provide cast-in-place, pre-cast concrete or die-molded fiberglass handholes/pull boxes as
per design for underground installations. Cast-in-place and pre-cast boxes shall be provided with reinforcing bars with material compressive strength no less than 11,000 psi, and shall be approved by Owner/Structural Engineer.

PART 3 EXECUTION

3.1 INSTALLATION - CONDUIT

A. Install products as indicated, in accordance with the applicable requirements of NEC, NEMA and the National Electrical Contractors Association's "Standard of Installation".

B. Cut conduit square using a saw or pipe cutter. De-burr cut ends. Joints in steel conduit must be painted with T&B Kopr shield and drawn up tight. Threads for rigid metal conduit and IMC shall be deep and clean. Running threads shall not be used. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement with brush to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Spray type of cement is not acceptable. Install raceway and conduit system from point of origin in outlets shown, complete with support assemblies including all necessary hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, clips angles, through bolts, brackets, saddles, nuts, bolts, washers, offsets, pull boxes, junction boxes and fittings to ensure a complete functional raceway system. Where vertical drops of conduit are made to equipment in open space, the vertical conduit shall be rigidly supported from racks supported on the floor.

C. Install rigid wall hot-dipped galvanized steel conduit or hot-dipped galvanized intermediate metal conduit for service entrance; feeders; wall or floor penetrations; mechanical rooms electrical rooms and exposed locations where there is a high potential subject to physical damage; exposed outdoor locations; damp locations or any location as per design drawing. The following exceptions permitted:

1. EMT
   a. In sizes up to and including 1-1/2 inch, may be used inside dry locations where not subject to mechanical damage. EMT may be used in air-conditioned spaces, such as accessible ceilings, dry wall partitions and exposed where 6 feet above the floor. EMT may not be used outside, in concrete, underground, in under floor spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation, or exposed within 6 feet of the floor. EMT shall not be used for medium voltage circuits.
   b. Where used for feeder circuits receptacle branch circuits and motor branch circuits EMT shall also contain a NEC grounding conductor.
   c. All conduits shall be concealed in walls or ceilings unless otherwise noted.

2. PVC (underground use only)
   a. Install PVC schedule 40 conduit where direct buried in earth.
   b. Type EB, Utility Duct, encased in concrete.

3. Liquid-tight
   a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install external ground wire on flexible conduit with grounding bushings. Maximum length shall be 6 feet minimum of 2 feet.

4. Flexible Metal Conduit
a. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips or motor vibrations, with internal ground wire. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be 6 feet minimum of 3 feet; minimum size shall be 3/4; and minimum size shall be ½ inch for lay-in light fixture whips.

D. Install conduits parallel and supported on Unistrut, or equal, trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. No raceways or boxes shall be supported using wire. Arrange conduit to maintain headroom and present a neat appearance. Conduit routes shall follow the contour of the surface it is routed on. Route exposed conduit and tray above accessible ceilings parallel and perpendicular to walls and adjacent piping. Maintain 12-inch clearance between conduit and heat sources, such as flues, steam pipes, and heating appliances. Wire ties or "wrap lock" are not permitted to support or secure conduit system. Fasten conduit with the following material:

1. Wood screws on wood
2. Toggle bolts on hollow masonry
3. Bolts and expansion anchors in concrete or brick
4. Machine screws, threaded rods and clamps on steel
5. Conduit clips on steel joists.
6. 4 inch x 4 inch penta-treated pine installed in pitch pans on roof, spaced at intervals not to exceed 5 feet.

E. Install conduits outside of building lines at a minimum depth of 30 inches below finished grade. Maintain twelve inches earth or two inches concrete separation between electrical conduits and other services or utilities underground. Encase all plastic service entrance conduits with concrete unless otherwise specifically detailed or noted on the drawings.

F. Ducts in concrete encased ductbanks shall be independently supported by interlocking module spacers by Formex or equal. Spacers shall provide 3 inches separation between adjacent ducts. Spacers shall be installed at 6 feet maximum intervals.

G. Ducts in concrete encased ductbanks shall be terminated in manholes, pull boxes, and vaults with interlocking terminators. A watertight tapered plug shall be furnished and installed in unused duct openings. Where terminators are installed in new work, they shall be poured-in-place.

H. Install underground conduits with sealing glands equal to OZ Type FSK exterior to the conduit and OZ type CSB, or equal internally at the point where conduits enter the building to prevent water seepage into the building.

I. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed.

J. Install expansion fittings in metal and PVC conduit as follows:

1. Conduit Crossing Building Expansion Joints:
   a. EMT all sizes
   b. IMC all sizes
   c. RMC all sizes
   d. PVC all sizes
2. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.

3. Unless expansion fitting has an integral bonding braid, as in Crouse-Hinds Type XC, a green insulated grounding conductor shall be pulled in the conduit. Both ends of this green grounding conductors shall be accessible for inspection.

K. Install conduit concealed in walls, partitions and above ceilings. Install conduit exposed in ceiling area (at structure) of boiler rooms, mechanical rooms and in other similar rooms where ceilings are not called for. Install conduit concealed in slab when finished areas below do not have ceiling. A written approval shall be obtained from Owner/Structural Engineer prior to construction.

L. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

M. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture if cable or wire are not installed immediate after conduit run. Tape covering conduit ends is not acceptable.

N. Provide 200 lb. nylon cord full length in empty conduit.

O. Where conduit penetrates fire-rated walls and floors, provide pipe sleeve two sizes larger than conduit; pack void around conduit with oakum and fill ends of sleeve with fire-resistive compound or provide mechanical fire-stop fittings with UL listed fire-rating or seal opening around conduit with UL listed foamed silicone elastomer compound equal to fire-rating of floor or wall.

P. Install no more than the equivalent of three 90-degree bends between boxes. Where four 90 degree bends are required, prior approval by the Engineer is required. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bodies shall be readily accessible and sized for the cables installed. Running or rolling offsets are not approved. Use factory long radius elbows for bends in conduit larger than 2-inch size. All parallel bends shall be concentric.

Q. Conduit entering / exiting cable tray shall be attached to the tray rail by means of strut bolted to the rail and standard manufacturer's accessories or by use of a UL listed conduit to tray connector. Conduit shall only enter / exit tray horizontally supported within 3 feet of the tray and extend into the tray 2 inches. Conduit shall be terminated with a grounding bushing and bonded to the ground conductor routed in the tray. (The attachment to the tray shall not be considered a ground.)

R. Pull string shall be provided full length in conduit designated for future use.

3.2 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET

A. Use flathead screws to fasten channel to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings on multi-outlet assembly.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path in accordance with the requirement of NEC.

3.3 INSTALLATION - WIREWAYS

A. Bolt wireways to steel channels fastened to the wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight wireway.

C. Mount rain tight wireway for exterior installation in horizontal position only.
3.4 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

C. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in.

D. Locate and install boxes to allow access, minimum 12 inches above ceiling except where space dimensions do not allow.

E. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation. Provide minimum 24-inch separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the two and pack openings with fiberglass.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Do not support junction boxes from the raceway systems. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.

G. Provide knockout plugs for unused openings.

H. Use multiple-gang boxes where more than one device is mounted together. Do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box.

K. Outlet boxes for switch shall not be used as junction boxes.

L. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

O. Set floor boxes level and flush with finish flooring material.

P. Prove tamper resistance receptacles in child care areas, psychiatric, and medical facilities.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED
   A. Distribution panelboards.
   B. Branch circuit panelboards.

1.2 REFERENCES
   A. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   B. NAME KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   C. NEMA PB 1 - Panelboards.
   D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
   F. NEMA AB 3 – Molded Case Breakers and Their Application
   G. ANSI/UL 67 – Electric Panelboards
   H. ANSI/UL 50 – Cabinets and Boxes
   I. ANSI/UL 508 – Industrial Control Equipment

1.3 SUBMITTALS
   A. Provide submittals in accordance with and in addition to Section 26 00 00.UT, Basic Electrical Requirements, and Division 01 for submittal requirement.
   B. Submit dimensioned drawings showing size, circuit breaker arrangement and equipment ratings including, but not limited to, voltage, main bus ampacity, integrated short circuit ampere rating, and temperature rating of circuit breaker terminations.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING
   A. Deliver distribution panelboards in factory-fabricated water-resistant wrapping.
   B. Handle panelboards carefully to avoid damage to material component, enclosure and finish.
   C. Store in a clean, dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Square D Company
   B. General Electric Company
   C. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 01 for substitution requirement.

2.2 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES
A. Provide molded case circuit breakers with manufacturer’s standard construction, bolt on type, with integral inverse time delay thermal and instantaneous magnetic trip in each pole. Circuit breakers shall be constructed using glass reinforced polyester insulating material providing superior dielectric strength. Provide circuit breakers UL listed as Type HACR for air-conditioning equipment branch circuits.

B. Circuit breakers shall have an over center, trip-free, toggle operating mechanism that will provide a quick-make, quick-break contact action.

C. Provide handle padlock attachments on circuit breakers where indicated on drawings. Device shall be capable of accepting a single padlock. All circuit breakers shall be capable of being individually padlocked in the off position.

D. The circuit breakers shall be connected to the bus by means of solidly bolted connection. In multi-pole breakers, the phase connections on the bussing shall be made simultaneously without additional connectors or jumpers. Multi-pole breakers shall be two or three pole as specified. Handle ties are not permitted. The circuit breaker shall have common tripping for all poles.

E. All circuit breakers shall be provided with visible ON and OFF indications.

F. Provide GFI circuit breakers as indicated on drawing or per NEC requirement.

G. Breaker voltage and trip rating shall be per drawings. Breaker faceplate shall indicate UL certificate standards with applicable voltage systems and corresponding short current rating as per drawings.

H. Molded Case Circuit Breakers:
   1. Breakers 400 ampere frame and less shall be manufacturer’s standard industrial construction, bolt-on type, integral inverse time delay thermal and instantaneous magnetic trip. Breakers 225 ampere through 400 ampere shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.
   2. Breakers 600 ampere frame and above shall be equipped with solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip.

I. Current Limiting Molded Case Circuit Breakers:
   1. Breakers 100 ampere frame shall be inverse time delay thermal and instantaneous magnetic trip.
   2. Breakers 250 ampere and 400 ampere frame shall be solid-state trip with built-in current transformers, solid-state trip unit and flux transfer shunt trip.
   3. Current limiting breakers shall protect downstream molded case breakers. Submit manufacturer’s test data proving the protection, from both peak currents and \( I^2T \) energy of downstream devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer’s written instructions and the applicable requirements of the NEC, NEMA, ANSI and the National Electrical Contractors Association’s "Standard of Installation".

B. Anchor enclosed firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured. Direct attachment to dry wall is not permitted. Freestanding panelboards shall be installed on a concrete housekeeping pad with anchors per manufacturer’s recommendation.
C. Mounting height:
   1. Distribution Panelboards: As per Drawings, but such that highest operating handle is no greater than 79 inches above finished floor.
   2. Branch Circuit Panelboards: As per Drawings, but such that highest operating handle is no greater than 79 inches above finished floor.
   3. Where panelboards occur in groups, the tops shall be aligned if it can be done without exceeding items 1 and 2 above.

D. Install panelboards plumb. Adjust trim to cover all openings. Seal all conduit openings and cap all used knockout holes.

E. Provide blank plates for unused open spaces in panelboards. Keep the front door closed after work to protect from damage, dirt, and debris at all times.

F. Install identification nameplates in accordance with Section 26 05 53.UT, Electrical Identification.

3.2 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and lugs.

B. Provide testing and start-up as indicated in Section 26 08 00 – Commissioning of Electrical Systems.

3.3 PANELBOARD SCHEDULE

A. The Contractor shall provide engraved, laminated plastic nameplates for circuit identification as indicated on the Drawings for distribution panelboards.

B. The Contractor shall fill the index directory inside the front door of branch circuit panelboards identifying each circuit as shown on Panel Schedule drawings. Where changes are made, the schedule shall reflect the changes. At the end of the job, these schedules shall reflect as-built record conditions.
**PROJECT INFORMATION**

**GENERAL NOTES**

A. All M/E/P work shall comply with applicable state & local building codes and requirements.

B. Refer to the specs for materials & methods for M/E/P construction.

C. Refer to the specs for subsurface requirements.

D. The M/E/P contractors shall visit the site & familiarize themselves with existing conditions which will impact construction of this project, prior to submitting bids.

E. All interruptions to utility services & all work in occupied spaces shall be scheduled with the building owner at least 7 days in advance & shall be performed at times which are acceptable to the building owner.

F. Where access is required to concealed M/E/P equipment, controls & devices, furnish access doors & install in walls & ceilings.

G. By existing conditions for locations of fire rated slabs & partitions, all pipe, conduit & sleeve penetrations of rated construction shall be sealed with a UL-listed fire & waterstop system. Ductwork penetrations thru rated construction shall be protected with fire or fire/smoke dampers which shall be provided at all locations where they are required by code, even if they are not shown on the drawings.

H. Equipment, ductwork, piping & conduct shall be independently supported from the building structure, separate from partition & ceiling supports.

I. Coordinate the location of HVAC equipment, piping & conduit between trades & provide offsets as required for installation in the available space.

J. Coordinate the exact location of HVAC equipment with lighting, piping & other construction to allow proper service access.

K. Piping & conduit shall be installed a minimum of 8" above the finished ceiling to provide clearance for light fixtures.

L. Equipment, piping & conduit shall be independently supported from the building structure, separate from partition & ceiling supports.

M. Coordinate the location of HVAC equipment, piping & conduit between trades & provide offsets as required for installation in the available space.

N. Refer to the utilityfields indoor air quality stage III lab upgrades for building standard mechanical specifications. These specifications shall be provided in the building standard.

O. Mechanical contractor shall confirm that all temperature control zones are consistent with those shown on the drawings. Any equipment where record drawings do not match existing conditions.

P. Contractor's bid price shall include returning any controls where required to accommodate new floorplan.

---

**ELECTRICAL SYMBOLS**

- **HAZARD**
  - **L1-10-A-B-R**
  - **SWITCH**
  - **DISCONNECT SAFETY**
  - **CURRENT CARRIED**
  - **NEW PANELBOARD (FLUSH/MOUNT)"

---

**DUCTWORK**

- **NEW SUPPLY AIR DIFFUSER**
- **RETURN AIR OR EXHAUST GRILL**
- **NEW RECTANGULAR OR ROUND DUCTWORK**
- **NEW FLEXIBLE DUCT**
- **NEW CONNECTION TO EXISTING DUCTWORK**
- **MANUAL BALANCING DAMPER**
- **GRAVITY BACKDRAFT DAMPER**
- **MECHANICAL DAMPER**

---

**E&M & ELECTRICAL SYMBOLS & ABBREVIATIONS**

- **DWG** DRAWING
- **RIC** ROUGH IN AND CONNECT
- **EUH** ELECTRIC UNIT HEATER
- **(D)** ITEMS TO BE DEMOED OR REMOVED
- **ETR** EXISTING TO REMAIN
- **(N)** NEW ITEMS
- **E** EXISTING
- **V** VACUUM
- **AW** ACID WASTE
- **AV** ACID VENT
- **CW** COLD WATER
- **NW** HOT WATER
- **NG** NATURAL GAS
- **AL** ABOVE LIGHT FIXTURE
- **OL** ABOVE LIGHT FIXTURE
- **D** DISCONNECT SAFETY SYMBOL
- **E2.01 ELECTRICAL RENOVATION**
- **E1.01 ELECTRICAL DEMOLITION**
- **M3.00 MECHANICAL DETAILS AND SCHEDULES**
- **M2.01 MECHANICAL RENOVATION**
- **M1.01 MECHANICAL DEMOLITION**

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**DRAWING LIST**

- **MEED0 MECHANICAL & ELECTRICAL SYMBOLS & ABBREVIATIONS**
- **M1.01 MECHANICAL DEMOLITION**
- **M2.01 MECHANICAL RENOVATION**
- **M3.00 MECHANICAL DETAILS AND SCHEDULES**
- **E1.01 ELECTRICAL DEMOLITION**
- **E2.01 ELECTRICAL RENOVATION**

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**ABBREVIATIONS**

- **F** EXISTING
- **N** NEW ITEMS
- **ETR** EXISTING TO REMAIN
- **(D)** ITEMS TO BE DEMOED OR REMOVED
- **(N)** NEW ITEMS
- **E** EXISTING
- **V** VACUUM
- **AW** ACID WASTE
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- **CW** COLD WATER
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- **E2.01 ELECTRICAL RENOVATION**
- **E1.01 ELECTRICAL DEMOLITION**
- **M3.00 MECHANICAL DETAILS AND SCHEDULES**
- **M2.01 MECHANICAL RENOVATION**
- **M1.01 MECHANICAL DEMOLITION**

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**SKETCH**

- **ME600 MECHANICAL & ELECTRICAL SYMBOLS & ABBREVIATIONS**
- **REVISION: CONSTRUCTION NO SCALE**
- **DATE: 07/01/19**

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**UT HEALTH SCIENCE CENTER - HOUSTON**

**UCT CHILLED WATER PUMPS**

**E&C PROJECT #3627.00**

---

**E&C Engineers & Consultants Inc.**

1010 Lamar, Suite 650
Houston, Texas 77002

Tel: 713/580-8800
Fax: 713/580-8888

www.eceng.com
1. REMOVE EXISTING CHILLED WATER PUMPS, PHASE SO ONLY ONE PUMP IS OUT AT A TIME. COORDINATE WITH THE OWNER. REMOVE ISOLATION PAD. REMOVE HORIZONTAL PIPE, ELBOW AND TRANSITION FITTING TO PUMP OUTLET.

2. REMOVE THE EXISTING CONCRETE BASE. THIS BASE IS APPROXIMATELY 16" TALL. REFER TO THE PICTURE BELOW.

3. REMOVE EXISTING VFDS AND HARMONIC GUARD.
1. Repour new concrete base at 6-12 inches tall for the new pump size. Invert a base shall sit on the new pad. Pour pad low enough to allow any pipe transitions as necessary for the new pump.

2. Replace with new pump as scheduled. Phase so only one pump is out at a time. Coordinate phasing with the owner. Make piping transitions as necessary. Provide new isolation pad. Provide pump with VFD. Make piping changes as required for new pump. This may include relocating the gauge tap into the horizontal pipe, raising the elbows to align with the pump inlet or removal of pipe to align with the outlet. From design basis and old catalogs with dimensions, the new pump is 1 3/4 inches wider and 7.5 inches longer than the existing pump. Verify with field conditions and submitted pump.

3. New VFD shall replace the old VFDS.
PUMP SCHEDULE

<table>
<thead>
<tr>
<th>UNIT NO.</th>
<th>LOCATION</th>
<th>SERVICE</th>
<th>TYPE</th>
<th>GPW</th>
<th>FT. HEAD</th>
<th>SHUT OFF</th>
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<tr>
<td>UCTChP-162</td>
<td>PUMP ROOM</td>
<td>BUILDING CHILLED WATER</td>
<td>SPLIT CASE</td>
<td>1500</td>
<td>105</td>
<td>166</td>
<td>250</td>
<td>48.7</td>
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</tbody>
</table>

NOTES:
1. MINIMUM REDUCER LENGTH TO BE TWO SUCTION PIPE DIAMETERS. MINIMUM SPOOL PIECE LENGTH TO BE ONE SUCTION PIPE DIAMETER.
2. MINIMUM INCREASER LENGTH TO BE TWO DISCHARGE PIPE DIAMETERS. MINIMUM SPOOL PIECE LENGTH TO BE ONE DISCHARGE PIPE DIAMETER.
3. 2' - 0" MINIMUM LENGTH FOR FLEXIBLE CONNECTION AND SPOOL PIECE.

TYPICAL HORIZONTAL SPLIT CASE PUMP PIPING

TYPICAL HORIZONTAL SPLIT CASE PUMP INSULATION
UT HEALTH SCIENCE CENTER - HOUSTON
UCT CHILLED WATER PUMPS
E&C PROJECT #3067.00

DRAWING NOTES

1. REMOVE 100A BREAKERS IN PANEL BSDPA SERVING PUMPS UCTCHP-1 & 2, REF. TO DRAWING E2.01.
2. REMOVE WIRE AND CONDUIT FROM BREAKER TO VFD. REF. TO DRAWING E2.01.
3. DISCONNECT FROM HARMONIC GUARD TO BE REMOVED BY MECHANICAL CONTRACTOR.
4. REMOVE WIRE AND CONDUIT FROM VFD TO PUMP, REF. TO DRAWING E2.01.
5. DISCONNECT FROM VFD TO BE REMOVED BY MECHANICAL CONTRACTOR. REF. TO DRAWING E2.01.
6. WORK TO BE PHASED SO ONLY ONE PUMP IS DOWN AT ANY TIME.
7. METER THE PANEL FOR NO LESS THAN 1 WEEK PRIOR TO REMOVAL OF PUMP. PROVIDE MAX AMP DRAW DURING THE METERING PERIOD.
NEW 125A BREAKER IN BSDPA

3/4, #6G, 1-1/4" C

DRAWING NOTES

1. PROVIDE NEW 125A BREAKERS. (2 TOTAL)
2. PROVIDE CONNECTION TO NEW PUMP AND VFD PROVIDED BY MECHANICAL CONTRACTOR,

E&C Engineers & Consultants Inc.
1010 Lamar, Suite 650
Houston, Texas 77002
Tel 713/580-8800
Fax 713/580-8888
www.eceng.com

TX Firm Registration No: F-003068

UT HEALTH SCIENCE CENTER - HOUSTON
UCT CHILLED WATER PUMPS
E&C PROJECT #5627.00

Digitally signed
by Heather Camden
Date: 2019.07.01 09:07:24-05'00'

STATE OF TEXAS
PROFESSIONAL ENGINEER

Digitally signed
by Heather Camden
Date: 2019.07.01 09:07:24-05'00'
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SECTION 23 00 10
MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Except as modified in this Section, General Conditions, Special Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23.

B. Applicable provisions of this Section apply to all Sections of Division 23 HVAC.

C. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements, and provide coordination drawings.

D. All work in these Sections shall be installed by craftsmen skilled in their trade.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. Furnish: The term "furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. Install: The term "install" is used to describe operations at project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. Provide: The term "provide" means to furnish and install, complete and ready for the intended use.
1.3 CODE REQUIREMENTS AND PERMITS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

D. The following building codes are applicable to this project.
   1. 2015 International Mechanical Code
   2. 2015 International Building Code
   4. State Energy Conservation Office (SECO) mandated state building compliance with ASHRAE 90.1-2013

1.4 REFERENCES

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, AWWA Specifications, Federal Standards or other standard specifications must comply with latest editions except where specified otherwise in individual Sections, revisions, amendments, or supplements in effect on date bids are received.

B. Requirements in reference specifications and standards are minimums for all equipment, materials and work. In instances where capacities, size or other features of equipment, devices, or materials exceed these minimums, meet listed or shown capacities.

1.5 SUBMITTALS

A. Equipment and Materials submittals must show sufficient data to indicate complete compliance with contract documents as follows:
   1. Proper sizes and capacities.
   2. That the item will fit in the available space in a manner that will allow proper service.
   3. Construction methods, materials, and finishes.

B. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.

C. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data for review for items of equipment and for principal materials proposed for installation. HVAC controls may be submitted separately provided the controls submittal is complete and coordinated with all other applicable trades. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.
D. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.

E. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.

F. Refer to Section 01 33 00 for additional submittal requirements

1.6 COORDINATION DRAWINGS

A. Prior to starting work, the Contractor shall provide coordination drawings for all areas of the building. The Contractor shall submit the coordination drawing for confirmation of the coordination process. The Contractor is responsible for all trade confirmation.

B. CAD. Provide 1/4 inch scale coordination drawings.
   1. Drawings shall show all equipment, ductwork, cable trays, fire protection system, coil pull spaces, chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room to verify space allocation and coordination of trades.
   2. Provide plan and elevation views detailing installation.
   3. Drawings shall include 1/4 inch scale drawing of each mechanical room. Drawing shall show coil pull spaces and coordination of all ductwork, all chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room. Provide plan and elevation views detailing installation.
   4. Contractor may not proceed with construction of MEP systems until trade coordination process has been demonstrated to be completed by the Contractor to the Architect, Engineer and Owner.

1.7 INTERFERENCE DRAWINGS

A. Interference drawings are drawings that indicate conflict between the various systems and other components of the building such as beams, columns, walls, etc. They shall be drawn to scale and shall include plans, elevations, sections and other details as required to clearly define the interference and to indicate the contractor's proposed solution.

B. They shall be submitted for approval whenever job measurements and an analysis of the drawings and specifications by the contractor indicate that the various systems cannot be installed without significant deviation from the intent of the contract. When such interference is encountered, work shall cease in the general area of the conflict until a resolution to the question has been approved.

1.8 GUARANTEE

A. Guarantee work for one year from the date of final acceptance of the project. During that period make good any faults or imperfections that may have arisen due to defects or omissions in materials or workmanship.
1.9 SERVICE

A. Perform service work required during the guarantee period including lubrication of bearings. Perform manufacturer’s recommended monthly service and provide Owner with written report. Cleaning of air filters and pipe strainers is not included.

1.10 RESOLUTION OF CONFLICTS

A. Where conflicts may exist between and/or within the drawings and/or specifications, the higher quality, greater quantity, more restrictive, and/or more expensive requirement shall be required and shall be the basis of Contractor pricing. The Contractor shall notify the A/E for resolution of the issue prior to executing the work in question.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacture, where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed in individual Sections of Division 23. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

B. Manufacturers’ names and catalog numbers specified under Sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition.

C. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturers’ list will be acceptable on approval.

D. Substitutions:
1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
3. The Architect/Engineer will not give approval to material salesmen or subcontractors, and only in writing to the successful Contractor after the project has been awarded.
4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.

7. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural or architectural, which may result from the substitution.

8. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

E. Basis of Design: Where a basis of design is indicated (i.e., scheduled products), that product was used for the purposes of established space requirements, structural design for the building, utility connections, etc. If the contractor elects to furnish a product other than the basis of design product (either another named acceptable manufacturer or via substitution) the contractor is responsible for any construction or design costs associated with the non-basis of design product.

2.3 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate (without cost to the Owner) that equipment performs within designated vibration limits indicated in the specifications, or as specified by manufacturer.

2.4 AIR FILTERS AND PIPE STRAINERS

A. Immediately prior to final acceptance of project, inspect, clean and service hydronic system strainers and replace disposable type air filters.

B. Turn over to Owner additional sets of spare filters and other spare parts as specified.

2.5 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cooperation with Other Trades: Cooperation with trades of adjacent, related, or affected materials or operations and of trades performing continuations of work under subsequent contract is considered a part of this work in order to effect timely and accurate placement of work and to bring together in proper and correct sequence the work of such trades.
B. Workmanship: Work must be performed by workmen skilled in their trade.

C. Installation of all equipment and materials must be complete. Installation shall meet requirements of specifications and manufacturer’s recommendations.

D. Electrical Wiring of Motors and Equipment. The Contractor shall note that the electrical design was based upon the mechanical equipment indicated on the mechanical construction documents and specifications. If Contractor proposes any mechanical equipment that requires changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 SPACE REQUIREMENTS

A. Consider space limitations imposed by contiguous work, including clearances required for service, in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

B. The following space allocation and coordination shall be followed, unless otherwise indicated on the construction drawings:
   1. Gravity-fed plumbing and roof drain line shall take priority over all other systems.
   2. Light fixtures and cable tray arrangements shall take priority in spatial layout. In areas with ceilings, other systems shall be routed above the light fixtures, and offset from above cable tray allowing for access and maintenance clearance.
   3. Install HVAC ductwork as close to the bottom of structural framing as possible while allowing clearance for installation of insulation wrap. Install ductwork to be accessible from the ceiling plane.
   4. Install HVAC chilled/hot water piping in the plane directly below HVAC ductwork unless indicated otherwise on drawings.
   5. Install fire sprinkler piping in the plane directly beneath the HVAC chilled/hot water piping. Do not install sprinkler piping directly below equipment requiring maintenance.
   6. Install domestic hot and cold water in the plane directly above the light fixtures.
   7. Refer to Division 26 for electrical and control wiring requirements.
   8. Install piping to permit removal of coils at air handling units and to permit access to all terminal unit components.

3.3 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.

B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.

C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

D. Assume total responsibility for and repair any damage to existing utilities or construction.
3.4 OPENINGS

A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.5 DELIVERY, STORAGE AND HANDLING

A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.

B. Cover all equipment stored exposed to elements with waterproof tarps, provide adequate ventilation.

C. At work completion, all work must be clean and in like new condition.

D. Storage of all mechanical equipment, piping materials and ductwork shall be in strict accordance with manufacturers written installation instructions.

E. Rotate air handler fans and pump shafts on routine basis.

F. Provide factory installed pipe caps for all pipes to be installed on the project.

G. Provide covers over all openings in ductwork stored or installed on the project.

H. Energize motor heaters with temporary power as soon as the motor is received on site.

I. Air Handling Units shall not be used as storage containers

3.6 LUBRICATION AND OIL

A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.7 OPERATING TESTS

A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.

B. Prove operations of control systems and all safeties, freezestats and alarms.

C. Make adjustments as required to ensure proper functioning of all systems.

D. Special tests on individual systems are specified under individual Sections.

3.8 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Furnish copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings in accordance with Specification 01 78 23. Detailed requirements for these items are as follows:
1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
   a. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
   b. Special tools and equipment required for testing and maintenance.
   c. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
   d. Recommended spares by part number and nomenclature and spare stocking levels.
   e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
   f. Troubleshooting, checkout, repair and replacement procurement procedures.
   g. Operating instructions including start up and shutdown procedures.
   h. Safety considerations including load limits, speed, temperature and pressure.

2. Provide O&M manuals for all HVAC equipment.

3.9 PROJECT RECORD DOCUMENTS

   A. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.

   B. Mark the drawings with a colored pencil.

   C. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed.

   D. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.

   E. At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these.

   F. Delivery of as-built prints and reproducibles is a condition of final acceptance.

3.10 TRAINING

   A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the manufacturer/Contractor to instruct the Owner's Representative and up to 8 members of the Owner's staff in the operation and maintenance of the entire system. Record training sessions on DVDs for instructing future technicians.
B. Provide training for the following pieces of equipment:

<table>
<thead>
<tr>
<th>Items:</th>
<th>HRs of Training Pre-Substantial Completion</th>
<th>HRs of Training at 6 months from Substantial Completion</th>
<th>HRs of Training at 11 months from Substantial Completion</th>
<th>Video Taping Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps</td>
<td>4</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. All training sessions shall be scheduled in coordination with the Owner's Representative 14 days in advance, attendance taken, and sign-in sheet and training materials included in the O&M manuals.

END OF SECTION
Specification 23 00 10 Comments and Revisions

<table>
<thead>
<tr>
<th>Date</th>
<th>Comment (Engineer)</th>
<th>Revision (Engineer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/7/13</td>
<td>Specification issued for comments (Erik Dietz)</td>
<td></td>
</tr>
<tr>
<td>5/28/2013</td>
<td>Specification issued for use (Erik Dietz)</td>
<td></td>
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<tr>
<td>10/19/2016</td>
<td>Need to update codes (J. Garcia)</td>
<td>Updated Paragraph 1.3 (E. Dietz)</td>
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<tr>
<td>10/26/2016</td>
<td>Need coordination drawings to be reviewed, not necessarily approved (S. Sevigny/G. Cobb).</td>
<td>Updated Paragraph 1.6, B and 1.6, C per recommendations (E. Dietz)</td>
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<tr>
<td>8/24/2017</td>
<td></td>
<td>Added Paragraph 2.02, E regarding basis of design products.</td>
</tr>
<tr>
<td>8/2/2018</td>
<td>&quot;University&quot; wording used. (D. Gusewelle)</td>
<td>Revised to say &quot;Owner&quot; (D. Gusewelle)</td>
</tr>
</tbody>
</table>
SECTION 23 05 19

METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes the following for hydronic piping:
   1. Thermometers.
   2. Gauges.
   3. Pressure and Temperature Taps.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, submit detailed shop drawings and manufacturer’s data, including:
   1. Measurement tolerances.
   2. Range.
   3. Accuracy.
   4. Device dimensions and connection sizes (include schedule indicating stem length versus pipe diameter).
   5. Scales.
   7. Valves that will be used for isolating gauges.

B. Submit a schedule for each device to be installed, including:
   1. Location.
   2. Pressure or temperature range of device and fluid measured.
   3. Temperature or pressure of fluid.
   4. Pipe size and bulb length of thermometers.
   5. Type of valve used with the Pressure Gauge.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Thermometers: Calibrate against standards traceable to the NIST and guaranteed accurate to plus or minus one scale division.

B. Pressure Gauges: ASME B40.1 Grade 2A accuracy 0.5 percent of scale range.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:
   1. Pressure Gauges: Ashcroft, Dwyer, Trerice, Weiss, Weksler
   2. Pressure/Temperature Taps: Peterson Engineering Company, Sisco or Trerice
2.2 PRESSURE GAUGES

A. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.
   1. Case: Liquid-filled type, polypropylene case, 4-1/2 inch diameter, solid front with blow-out back.
   2. Bourdon Tube: Bronze or 316 stainless steel with brass or stainless steel socket.
   3. Movement: 300 series stainless steel rotary type with stainless steel bushings
   4. Dial: White face with black figure.
   5. Pointer: Red or black, micro adjustable.
   7. Ring: Fiberglass polypropylene.
   8. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
   9. Gauge Ranges
      a. Provide 0 - 160 psi gauges for 150 psi chilled/hot water service.
   10. Provide liquid filled gauges for all pressure gauges upstream and downstream of pumps.

B. Pressure-Gauge Fittings:
   1. Valves: NPS 1/4 brass or stainless-steel needle type.
   2. Siphons: NPS 1/4 coil of brass or stainless-steel tubing with threaded ends.
   3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.3 PRESSURE AND TEMPERATURE TAPS:

A. Taps. Provide 1/2” solid brass fittings which will receive either a pressure or temperature probe, with valve core of Nordel and fitted with a color coded cap and gasket. P/T Taps shall be rated for 275 degrees F. and 1000 psig. Provide long stem type for insulated pipe.

B. Instruments. Provide two each, No. 500 "Pete's Plug" pressure gauge adapters with four gauges and probes and four each 5" stem pocket thermometers: Two each, thermometers for chilled water, heating and domestic hot water systems, when applicable. Applicable meaning the system is being installed as part of the project. "Pete's Plugs” to match insulation thickness.

PART 3 - EXECUTION

3.1 GAUGE INSTALLATIONS

A. Provide pressure gauges in the following locations:
   1. Suction and discharge side of each pump.
   2. Each hydropneumatic tank.
   3. Inlet and outlet of each air handling unit coil.
   4. Supply and return piping connections of coils (where shown on details).
   5. Inlet and outlet of each heat exchanger vessel.
   6. As shown on Drawings and control schematics.

B. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

C. Install needle-valve in piping for each pressure gauge for fluids.
D. Install snubber for gauges associated with pumps.
E. Provide fittings as necessary to install pressure gauge in the vertical position.

### 3.2 Pressure and Temperature Tap Installations

A. Provide pressure and temperature taps at the following locations:
   1. Inlet and outlet of each coil connection.
   2. Inlet and outlet of each hydronic control valve
   3. Inlet and outlet of supply and return connections of each heat exchanger.
   4. Where shown in details on mechanical drawings.

B. Provide liquid filled gauges upstream and downstream of all pumps.

### 3.3 Connections

A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance for thermometers, gauges, machines, and equipment. Thermometer

### 3.4 Adjusting

A. Adjust faces of meters and gauges to proper angle for best visibility.

END OF SECTION
SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes:
   1. Equipment labels.
   2. Pipe labels.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.4 RELATED WORK

A. Painting. Division 09.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 10.

B. Equipment Labels
   1. Provide three ring binder including equipment label information (8-1/2 x 11 inch paper).
   2. Each type of equipment (pumps, AHUs, etc) shall be individually tabbed in the binder.
   3. For each item of equipment to be labeled, provide equipment identification number, floor, room location, and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Marking Services, Inc.

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 x 3/4 inch.
   3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black. (Similar to Sherwin-Williams SW 4090)

C. Background Color: Background to contrast with letter color.

D. Maximum Temperature: Able to withstand temperatures up to 160°F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch x 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 to 3/4 the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.
2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment. Use fasteners for all equipment labels where possible. Where it is not possible to use fasteners, use adhesive.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. Do not label drain piping where the floor drain is located adjacent to the equipment.

B. Provide pipe labels for the following piping systems:
   1. Chilled Water Systems
SECTION 23 07 00
INSULATION - GENERAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section specifies the general requirements for furnishing and installing insulation. These requirements apply to all other Mechanical Division sections specifying insulation.

B. All the piping in mechanical rooms and equipment rooms including areas without ceilings is to be considered as exposed piping or ductwork.

1.2 RELATED WORK

A. Internal insulation for air units is specified in the sections on air handling units. The units do not require external insulation.

B. Insulation. Refer to specific sections on individual insulation types.

C. Section 09900 or 09901, Painting.

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM).

B. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE).

C. North American Insulation Manufacturers Association (NAIMA).


E. National Fire Protection Association (NFPA).

F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

G. Underwriter's Laboratories (UL).

H. Underwriter's Laboratories Environment (UL Environment).

1.4 FIRE HAZARD RATING

A. All equipment, duct and piping insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements.
1.5 **QUALITY ASSURANCE:**

A. Applicator shall be a company specializing in insulation application with minimum 5 years' experience.

B. Products shall not contain formaldehyde, asbestos, lead, mercury, or mercury compounds.

C. Fiberglass products shall have a minimum of 20 percent recycled glass content certified and UL Validated.

1.6 **SUBMITTALS**

A. Product Data. Submit product data on each insulation type, adhesive and finish to be used in the work. Include manufacturer’s installation instructions, list of materials and thickness for equipment scheduled.

B. Samples. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with the work.

C. Shop Drawings: Show details for the following:
   1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Attachment and covering of heat tracing inside insulation.
   3. Insulation application at pipe expansion joints for each type of insulation.
   4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Removable insulation at piping specialties, equipment connections, and access panels.
   6. Application of field-applied jackets.
   7. Application at linkages of control devices.
   8. Field application for each equipment type.

1.7 **ACCEPTABLE MANUFACTURERS**

A. Acceptable manufacturers are listed under individual specification sections.

1.8 **INSULATION**

A. Insulate in accordance with appropriate specification section.

**PART 2 - EXECUTION**

2.1 **COMMON INSULATION REQUIREMENTS**

A. All materials shall be delivered to the site shall be dry, undamaged and maintained in good condition throughout the progress of the project.

B. Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner’s representative.
C. Insulate valves, fittings, flanges and special items in accordance with appropriate specification section.

D. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any damage caused by the condensation.

E. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

F. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

G. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

H. Install insulation with longitudinal seams at top and bottom of horizontal runs.

I. Install multiple layers of insulation with longitudinal and end seams staggered.

J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

K. Keep insulation materials dry during application and finishing.

L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

M. Install insulation with least number of joints practical.

N. Where vapor barrier is indicated, seal joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier coating/mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier coating/mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

O. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.
2.2 ACCESSORIES

A. Installation of accessories such as jacketing, bands, adhesives, insulation shields, coatings, finishes, etc. is specified under individual specification sections.

END OF SECTION
SECTION 23 07 16
EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED
A. This Section provides for furnishing and installing insulation for both high and low temperature vessels and equipment.
B. Low temperature installations include chilled water pumps.

1.2 RELATED WORK
A. Section 23 21 13, Water Specialties.
B. Section 23 07 00, Insulation - General.

1.3 SUBMITTALS
A. Provide Submittals in accordance with Section 23 07 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Flexible Elastomeric (Type E2)
   1. Armacell
   2. K-Flex USA.

2.2 INSULATION
A. Type E2, Flexible Elastomeric insulation: Provide closed-cell expanded rubber materials complying with ASTM C534, Type 1 for tubular materials or ASTM C534, Type 2 for sheet materials. Insulation shall have a maximum "K" factor of 0.28 Btu-in./h-ft²-°F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

2.3 CEMENT AND COATINGS
A. Low Temperature:
   1. Adhesive: Furnish Armaflex 520 BLV Low VOC Adhesive, Foster 85-75 or Childers CP-82 to seal longitudinal labs and to adhere butt joint covers.
   2. Finish: Furnish Armaflex WB or Foster 30-64 water based latex enamel finish.
B. Reinforcing Mesh:
   1. Reinforcing Mesh: Fiberglass or polyester. 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10
PART 3 - EXECUTION

3.1 GENERAL

A. Pressure test all piping prior to insulating equipment.

B. Clean surfaces prior to installation and remove all dirt.

3.2 EQUIPMENT INSULATION APPLICATION AND THICKNESS SCHEDULE

<table>
<thead>
<tr>
<th>Service</th>
<th>Application</th>
<th>Insulation Type</th>
<th>Insulation Thickness-Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water Pump</td>
<td>Chilled Water System</td>
<td>E2</td>
<td>1</td>
</tr>
</tbody>
</table>

3.3 TYPE E2, FLEXIBLE ELASTOMERIC INSULATION

A. Adhere sheet insulation to clean, oil-free metal surfaces by compression fit method and full coverage of adhesive. Seal butt joints with same adhesive. Where two layers are used, stagger joints.

B. Apply finish to cover insulation.

C. Pumps.

1. The pump must be started up with vibration testing completed prior to insulating.

2. Clean pump prior to installation and remove all dirt. Carefully measure and sheets for direct application on chilled water pumps. Apply adhesive to pump and to back side of insulation. Allow adhesive to dry to touch but remain tacky before joining surfaces. Spread butt seams and apply adhesive to both butt edges. Align carefully and join butt edges. Refer to manufacturer’s instructions for further information and details.

3. Provide removable insulation (friction fit) for accessible areas of pump. Ensure pump shaft is insulated on opposite side of motor. Insulation shall not be applied directly to moving surfaces.

4. Apply a finish to the cover as specified above.

5. Install equipment identification nameplate and "spare" manufacturer's pump performance nameplate on pump inertia base with corrosion resistant fasteners.

END OF SECTION
SECTION 23 07 19

PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Piping insulation for Chilled Water Piping within building envelope.
   2. Furnishing and installation of insulation.

1.2 REFERENCES

C. ANSI/ASTM C 552 - Cellular Glass Block and Pipe Thermal Insulation.
D. ASTM B 209 - Aluminum and Aluminum-alloy Sheet and Plate.

1.3 QUALITY ASSURANCE

A. Applicator. Company specializing in piping insulation application with five years minimum experience.
B. Materials. UL/ULC Classified per UL 723 or Flame spread/fuel contributed smoke developed rating of 25/50 in accordance with ASTM E84.

1.4 SUBMITTALS

A. Refer to Specification 23 07 00.
B. Submit product data on insulating materials, including manufacturer's safety and installation instructions.
C. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Phenolic Foam
      a. Dyplast
      b. Resolco Insulphen
      c. ITW
2.2 INSULATION

A. Type P5. Furnish minimum 2.5-pound density rigid closed-cell phenolic foam insulation with factory applied all service reinforced vapor barrier (ASJ) jacket having integral laminated aluminum vapor barrier. Insulation shall be in accordance with ASTM C-1126 with a maximum “K” factor of 0.18 BTU-in/hr-ft²-°F at 75°F.

2.3 INSULATION SHIELDS AND SADDLES

A. Field Fabricated:
1. Use high compression strength Phenolic Foamglas blocks (HLB 1600) that will support the bearing area at hangers and supports.
2. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 2 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below.
3. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference.
4. Adhere metal shield to insulation so that metal will not slide with respect to insulation. Furnish vapor barrier and sealant where used on low temperature service (below 100°F).

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Insulated Section</th>
<th>Minimum U.S. Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length in Inches</td>
<td>Gauge of Metal Shield</td>
</tr>
<tr>
<td>2 1/2” and smaller</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>3” to 4”</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>6” to 12”</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>14” and larger</td>
<td>24</td>
<td>12</td>
</tr>
</tbody>
</table>

5. At Contractor’s option, factory-made insulation shields may be provided as made by Anvil Fig 168, equivalent by Pipe Shields, Inc., or equal. Insulation should extend at least 1 inch beyond metal. Select proper shield for service and pipe span.

6. For Type P2 insulation, factory-made insulation shields such as Armafix IPH may be used at Contractor’s option.

7. For Type P5 insulation, use minimum 5 pound density insulation or denser as required by manufacturer at all pipe supports.

B. Saddles: Fit piping 2 inches through 10 inches operating at high temperatures with Anvil Figure 161 through 164 protection saddles, or similar saddles of proper design for specified insulation thickness. Fit pipe sizes over 10 inches with Anvil Figure 163A through 165A or similar saddle as required by insulation thickness specified.

C. All shields are to be secured by 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals

2.4 JACKETS

A. PVC Jackets: Provide molded or mitered covers for flanges, valves and fittings similar to PROTO or Johns Manville Zeston 2000.

B. Canvas or Glass Jackets and Lagging Adhesive/Coating: UL listed treated cotton fabric, 6 ounce/square yard or low odor glass cloth, Childers CP-50AMV1, Fosters 30-36 lagging adhesive or approved equal.
C. Factory-Applied Jackets
   2. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM 1136 Type I, II, III, IV and VII.
   3. ASJ: White, kraft paper, fiberglass reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.
   4. ASJ-SSL: ASJ with self-sealing, pressure sensitive, acrylic based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.5 SEALANT, ADHESIVE AND FINISH

A. Phenolic Foam - Low Temperature (Below 70°F):
   1. Flashing Sealant: Furnish Childers CP 76 or Foster 95-44 elastomeric sealant at valve covers, anchors and hangers.
   2. Lap Adhesive: Furnish Childers CP-82 or Foster 85-20 to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
   3. [Vapor Barrier Coating: Furnish Childers CP-38 or Foster 30-80 with reinforcing mesh on all insulated fittings, flanges, and valves. Coating permeance shall be no greater than 0.013 perms at 43 mils dry as tested by ASTM E96. Coating must comply with MIL-C-19565C, Type II and be QPL listed. All ASJ seams shall be coated with vapor barrier coating to prevent moisture ingress. Outdoors: Foster 30-90; Childers CP-35 only. White]

B. Reinforcing Mesh: Fiberglass or polyester. 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10

2.6 FITTINGS

A. Provide pre-molded fittings and elbows molded in two matching half sections of same insulation thickness as adjoining piping. As an alternative, provide mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs. No insert or blanket insulation allowed.

2.7 PRIMER

A. Polyguard RG-CHW for surface temperatures less than 130°F, RG-2400 LT for piping with surface temperatures between 130°F and 250°F. Application thickness shall be 25 mils.

B. Global Encasement Rust Inhibition Primer. Application thickness shall be minimum 3 mils (dry)

C. Sherwin Williams Pro-Cryl Universal Acrylic Primer. Application thickness shall be minimum 3 mils (dry).

2.8 ALUMINUM JACKET

A. Piping. Furnish for finishing interior insulated pipe, a prefabricated jacket of ASTM B209 aluminum, 0.020 inch thick, with factory-applied 2-mil moisture barrier.
B. Valves, Fittings and Flanges. Provide complete coverage of all valves, fittings and flanges, provide aluminum covers, 0.020 inch thick, ASTM B209 aluminum.

C. Straps and Seals. Furnish 1 inch x 0.010 inch, ASTM B209 aluminum strapping and seals for applying aluminum jacket and covers to provide completely weather tight covering of all insulation including caps, flanges and end of lines.

D. Metal Jacketing Sealant: Furnish 1/8” bead of Foster 95-44 or Childers CP-76 underneath all metal jacketing laps to prevent water entry on outdoor applications.

PART 3 - EXECUTION

3.1 PIPE

A. Pressure testing of piping systems shall be complete prior to application of insulation.

B. Prior to insulating piping,
   1. Remove all oil, grease, cutting oils, dirt and other contaminants. Use suitable solvents, steam cleaning with detergent, or fresh water wash with detergent. Follow with thorough fresh water rinse.
   2. Provide primer coat on all chilled and steel piping in accordance with manufacturer’s recommendations, to include field welds and over factory applied paint/coating, in total compliance with mechanical identification section and compatible with and approved by the insulation manufacturer. Painting must be completed and approved prior to installation of insulation.

C. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant.

D. Type P5 Phenolic Foam - Low Temperature:
   1. Where piping is interrupted by fittings, flanges, valves or hangers and at intervals not to exceed 25 feet on straight runs, an isolating vapor seal shall be formed between the vapor barrier jacket and the bare pipe by liberal application of the vapor barrier sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to an along 2 inches of the jacket.

3.2 VALVES, FLANGES AND FITTINGS

A. Low Temperature:
   1. Insulate all valves, flanges and fittings with molded fitting covers secured with wire. Thickness of insulation shall be equal to that adjoining piping.
   2. Finish with two coats vapor barrier coating reinforced with reinforcing mesh. The application shall provide a minimum dry film thickness of 37 mils.

3.3 SHIELDS AND HANGERS

A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.
B. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.4 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Continue insulation with vapor barrier through penetrations.

C. In exposed piping areas, locate insulation and cover seams in least visible locations. For outdoor installations seal jacket lap with 1/8" bead of metal jacketing sealant underneath each lap to prevent infiltration of water beneath jacket. On horizontal piping place overlap at side of pipe arranged so that water will run off of jacket and not into seam lap.

D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

E. Neatly finish insulation at supports, protrusions, and interruptions. Use 1-1/2 inch Type P2 insulation to insulate drains gauges, thermometers, and strainers.

3.5 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

A. Provide insulation with minimum thickness and conductivity values in compliance with ASHRAE standard 90.1-2013, Table 6.8.3-1,2, but not less than thicknesses specified in this specification and as required to prevent condensation. Where multiple materials are listed for a single service and location, it is the Contractor's option to choose from the allowable insulations.

<table>
<thead>
<tr>
<th>Service</th>
<th>Location</th>
<th>Insulation Type</th>
<th>Pipe Sizes</th>
<th>Insulation Thickness-Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water</td>
<td>Interior</td>
<td>P5</td>
<td>1-1/2&quot; and smaller</td>
<td>1</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>Interior</td>
<td>P5</td>
<td>2” to 6”</td>
<td>1-1/2</td>
</tr>
</tbody>
</table>

3.6 ALUMINUM JACKET

A. Apply aluminum jacket and covers according to manufacturer’s recommendations, using aluminum strapping and metal jacketing sealant to provide completely weathertight covering. Completely encapsulate insulation on all piping, valves, flanges, reducers, etc.
B. Provide aluminum jacket for all piping within 84 inches of finished floor in air handler mechanical rooms, pump rooms, penthouses and exposed occupied spaces in the building. Do not install jacketing on AHU Condensate drains unless noted otherwise. Do not install jacketing on flexible pump connectors or expansion joints.

END OF SECTION
SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Quality Assurance.
   2. Distributed Processing Units/Quantity and Location.
   3. Sequence of Work.
   4. Devices and Equipment.

B. Contractor shall furnish and install a direct digital control and building automation system (BAS). The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves (except where noted otherwise) to perform control sequences and functions specified. The BAS for this Project will generally consist of monitoring and control of systems described herein. Reference shall also be made to control Drawings, Sequence of Operation, and points lists.

C. This Section defines the manner and method by which these controls function as well as the materials to be used.

D. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections.
   1. Control wiring between field-installed controls, indicating devices, and unit control panels.
   2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
   3. Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.
   4. All other necessary wiring for fully complete and functional control system as specified.

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference (prior to the date of contract) shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
   1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

3. NFPA 70 - NEC

4. Telecommunications Industry Standards:

5. Underwriters Laboratories:
   b. UL 508a: Industrial Control Panels.

6. NEMA Compliance:
   a. NEMA 250: Enclosure for Electrical Equipment.
   b. NEMA ICS 1: General Standards for Industrial Controls.

7. Institute of Electrical and Electronics Engineers (IEEE)
   b. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN.
   c. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN.

1.4 DEFINITIONS

A. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.

B. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).

C. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications.

D. BACnet/BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes.

E. BACnet Interoperability Building Blocks (BIBB): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a Specification.

F. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended or required destinations.

G. Building Automation System (BAS): The entire integrated management, monitoring, and control system.
H. Building Controller (BC): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the LAN backbone and sub-LANs, and data storage for trend information, time schedules, and alarm data.

I. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135).

J. Client: A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.

K. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).

L. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.

M. Control Systems Server (CSS): This shall be a computer (or computers) that maintains the systems configuration and programming database. This may double as an operator workstation.

N. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic.

O. Functional Profile: A collection of variables required to define key parameters for a standard application. For the HVAC industry, this would include applications like VAV terminal units, fan coil units, etc.

P. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-2001).

Q. Hand Held Device (HHD): Manufacturer’s microprocessor based device for direct connection to a Controller.

R. IT LAN: Reference to the facility’s Information Technology network, used for normal business-related e-mail and Internet communication.

S. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS.

T. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.

U. Local Supervisory LAN: Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs and CSSs and the LAN to which the GEMnet will be interfaced. See System Architecture herein.

V. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard (ASHRAE/ANSI 135).

W. Owner WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.
The Native BACnet: A building automation or monitoring device that does not require any additional module, gateway, or driver to communicate to other devices with BACnet communication protocol. The ability to communicate via BACnet is built-in and the device should be able to communicate immediately when connected to a network with other BACnet devices.

Y. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.

Z. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.

AA. Operator Workstation (OWS): The user’s interface with the BAS system. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.

BB. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.

CC. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.

DD. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135).

EE. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture herein.

FF. Router: A device that connects two or more networks at the network layer.

GG. Secondary Controlling LAN: LAN connecting AACs and ASCs, generally lower speed and less reliable than the Primary Controlling LAN. Refer to System Architecture herein.

HH. Server: A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.

II. SQL: Standardized Query Language, a standardized means for requesting information from a database.

JJ. Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable.

KK. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.
1.5 QUALITY ASSURANCE

A. Product Line Demonstrated History: The product line being proposed for the Project must have an installed history of demonstrated satisfactory operation for a length of one (1) year since date of final completion in at least ten (10) installations of comparative size and complexity. Submittals shall document this requirement with references.

B. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than 5 years. Firms with experience in DDC installation projects with point counts equal to this Project and systems of the same character as this Project. If installer is a Value Added Reseller (VAR) of a manufacturer’s product, installer must demonstrate at least three years prior experience with that manufacturer’s products. Experience starts with awarded Final Completion of previous projects. Submittals must document this experience with references.

C. Installer's Experience with Proposed Product Line: Firms shall have specialized in and be experienced with the installation of the proposed product line for not less than one year from date of final completion on at least three (3) projects of similar size and complexity. Submittals shall document this experience with references.

D. Installer’s Field Coordinator and Sequence Programmer Qualifications: Individual(s) shall specialize in and be experienced with control system installation for not less than five (5) years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than two (2) projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. Proposed individuals must show proof of the following training:

E. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the manufacturer on that product line for installation and configuration.

F. Programming Training: Individuals involved with programming the Site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the manufacturer.

G. Installer’s Service Qualifications: The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum five (5) year history of servicing installations of similar size and complexity. Installer must also document at least a one year history of servicing the proposed product line.

H. Installer’s Response Time and Proximity:
   1. Installer must maintain a fully capable service facility within a 60 mile radius of the Project Site. Service facility shall manage emergency service dispatches and maintain inventory of spare parts.
   2. Emergency response times are listed below in this Section. Installer must demonstrate ability to meet response times.

I. The BAS and components shall be listed by Underwriters Laboratories (UL 916 and 508a) as an Energy Management System.

J. All controllers installed shall be BTL listed for no less than one year and be Native BACnet controllers.
1.6 SUBMITTALS

A. During bid, contractor shall submit the expected number of IT data drops to allow for review of the proposed system architecture (all IP based or a combination of IP and other communication wiring).

B. Within 90 days of notice to proceed, contractor shall submit drawings showing required IT data drops on architectural backgrounds (height above finished floor and quantity). Drawings shall include any spare drops.

C. All approved complete submittals shall be provided as a hard copy for the owner at the completion of the project. Digital copies shall be provided during the construction phase.

D. Functional Intent: Throughout the Contract Documents, detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent. However, these will only be allowed with prior approval.

E. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and operation and maintenance (O&M) information shall also be provided in electronic format as follows:
   1. Drawings and Diagrams: Shop Drawings shall be provided on electronic media as an AutoCAD drawing per Owner’s CAD standards. All ‘x reference’ and font files must be provided with AutoCAD files.
   2. Other Submittals: All other submittals shall be provided in PDF format.

F. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate items.

G. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.
   1. Shop Drawings: Submit Shop Drawings electronically on AutoCAD software for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Shop Drawings shall contain the following information:
      a. System Architecture and System Layout:
         1) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.
2) Provide floor plans locating all control units, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing conditions shall be maintained accurately throughout the construction period and the Record Drawings shall be updated to accurately reflect accurate, actual installed conditions.

b. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include written description of sequence of operation.

c. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

d. Label each control device with setting or adjustable range of control.

e. Label each input and output with the appropriate range.

f. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.

g. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination Drawings on separate Drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that is existing, factory-installed and portions to be field-installed.

h. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.

i. Sheets shall be consecutively numbered.

j. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.

k. Table of Contents listing sheet titles and sheet numbers.

l. User Interface Graphic Screens.

m. Trends.

n. Alarms.

o. Legend and list of abbreviations.

p. Submit along with Shop Drawings but under separate cover calculated and guaranteed system response times of the most heavily loaded LAN in the system.

2. BACnet Protocol Information:

a. Submit the following:

1) BACnet object description, object ID, and device ID, for each I/O point. (required for integration into the existing system).

2) Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.

3) Submit PICS indicating the BACnet functionality and configuration of each controller.
H. Record Documents:
   1. Record copies of product data and control Shop Drawings updated to reflect the final installed condition.
   2. Record copies of approved control logic programming and database on paper and on CD’s. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of Shop Drawings and including changes to programs made during specified testing.
   3. Record copies of approved Project specific graphic software digitally.
   4. Provide network architecture Record Drawings showing all nodes including a description field with specific controller identification, description and location information.
   5. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.
   6. Provide record riser diagram showing the location of all controllers.
   7. Maintain Project record documents throughout the Warranty Period and submit final documents at the end of the Warranty Period.

I. Operation and Maintenance Data:
   1. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
   2. Submit BAS User’s Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
   3. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
   4. Include all submittals (product data, Shop Drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 01.
      a. Contractor shall provide Owner with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution channel as to dealers or branches. This service will be provided for five (5) years as part of the Contract price, and will be offered to Owner thereafter for the same price as to a dealer or branch.
      b. Manufacturer’s Certificates: For all listed and/or labeled products, provide certificate of conformance.
      c. Product Warranty Certificates: Submit manufacturers product warranty certificates covering the hardware provided.

1.7 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

1.8 WARRANTY

A. Contractor shall warrant all products and labor for a period of 1 year after Substantial Completion. Controllers shall be provided with a 5-year parts/labor warranty.
B. The Owner reserves the right to make changes to the BAS during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any such changes made by Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS. Any disagreement between Owner and Contractor on such matters shall be subject to resolution through the Contract ‘Disputes’ clause.

C. At no cost to the Owner, during the Warranty Period, Contractor shall provide maintenance services for software, firmware and hardware components as specified below:
1. Maintenance services shall be provided for all devices and hardware specified in the Contract Documents. Service all equipment per the manufacturer’s recommendations. This includes monthly system health reports to identify points that are not in auto (or overridden), devices that are offline, and communication issues. On a quarterly basis controls shall include any loop tuning required for stable operation.
2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the Owner to the Contractor. Emergency service shall be provided 24 hours per day, 7 days per week, and 365 days per year with no exceptions and at no cost to the Owner.
3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the Owner to the Contractor.
4. At any time during the Warranty Period that Contractor is on Site for maintenance, emergency, or normal service, Contractor shall notify Owner and the local building operating personnel. Contractor shall notify said personnel of all work anticipated being involved for the service work.
5. Contractor shall specify a maximum of three telephone numbers for Owner to call in the event of a need for service. At least one of the lines shall be attended at any given time, at all times. Alternatively, pagers or phone numbers can be used for technicians trained in system to be serviced. One of the three notified technicians shall respond to every call within 30 minutes.
6. Technical Support: Contractor shall provide technical support by telephone throughout the Warranty Period.
7. Preventive maintenance shall be provided throughout the Warranty Period in accordance with the hardware component manufacturer’s requirements.
8. In the last month of the Warranty Period, all System software and controller firmware, software, drivers, etc. will be upgraded to the latest release (version) in effect at the end of the Warranty Period.

1.9 WORK BY OTHERS

A. Control Valves furnished under this Section shall be installed under the applicable piping Section under the direction of the BAS Provider who will be fully responsible for the proper operation of the valve.

B. Control Dampers furnished under this Section shall be installed under the applicable air distribution or air handling equipment Section under the direction of the BAS Provider who will be fully responsible for the proper operation of the damper.
C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the BAS Provider who will be fully responsible for the proper installation and application.

D. Variable Frequency Drives furnished under section 23 05 13 shall be provided with serial communication protocol information specific to the selected BAS Provider. BAS Provider shall be fully responsible to interface and make available VFD information in the building automation system as monitor only information.

E. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120 volt (V) control devices controlling 120V equipment, Division 26 Contractor shall extend power wiring to the equipment. BAS Provider shall extend it from the equipment to the control device.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction. The new BAS Database shall be prepared and individual points shall be enabled to be broadcast via BACnet/IP. Full read/write access to monitor, command, and reset setpoints shall be enabled through the JCI front end. A JCI Network Integration Engine will be required to integrate into the existing front end.

B. Provide electronic control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

C. Contractor shall be responsible for all integration tasks to fully integrate with the owners existing front end. No downtime to the existing front end is acceptable. Coordinate on the existing front end with the owner.

2.2 MANUFACTURERS – BAS/DDC SYSTEM

A. The BAS and digital control and communications components installed as work of this Contract shall be an integrated distributed processing system of the following manufacturers using BTL listed open/native BACnet protocol. No other products will be considered as substitutions. Manufacturers shall be capable of integrating with owners existing Johnson Controls front end system.

1. Siemens Building Technologies
2. Automated Logic
3. Johnson Controls – Basis of Design

2.3 ATTIC STOCK

A. Provide two addition controllers of each type utilized on the project for owner’s attic stock.
2.4 **UNIFORMITY**

A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

2.5 **MATERIALS AND EQUIPMENT**

A. Secondary LAN Communication Wiring and BAS low voltage wiring/cables: All wiring shall be in accordance with the latest edition of the National Electrical Code and Division 26.
   1. Contractor shall supply all communication wiring between Building Controllers, AAC’s, ASC’s and local and remote peripherals outside the IT infrastructure.
   2. Local Supervisory LAN: For any portions of this network required under this Section of the Specification, Contractor shall comply with Division 27 Communication specifications. Network shall be run with no splices and separate from any wiring over thirty (30) volts.
   3. Secondary Controller LANs: Communication wiring shall be individually 100 percent shielded pairs per manufacturer’s recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated, and wiring shall be grounded as recommended by building controller manufacturer.
      a. Wet / Damp Locations – Wiring in underground raceways or raceways which are subject to moderate degrees of moisture shall be listed for installation in wet locations. Direct burial wiring without a raceway is prohibited.
   4. BAS low voltage wiring/cables: All cables shall have legible printed sleeve identification labels at each device and the panel termination. Each label shall be identified with the entire BAS point name.

B. Signal Wiring: Contractor shall run all signal wiring in accordance with the latest edition of the National Electrical Code and Division 26.
   1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100 percent shielded pair, minimum 18-gage wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
      a. Wet / Damp Locations – Wiring in underground raceways or raceways which are subject to moderate degrees of moisture shall be listed for installation in wet locations. Direct burial wiring without a raceway is prohibited.
   2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

C. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with the latest edition of the National Electrical Code and Division 26.
   1. Low voltage control wiring shall be minimum 18-gage, twisted pair, 100 percent shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.
      a. Wet / Damp Locations – Wiring in underground raceways or raceways which are subject to moderate degrees of moisture shall be listed for installation in wet locations. Direct burial wiring without a raceway is prohibited.
2.6 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with ‘two-wire’ type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

2.7 CURRENT SWITCHES (CS)

A. Provide a high performance miniature split-core current status switch with adjustable set point (where indicated). The current status switch shall have an operating range of between 2.5 – 135 amps and be able to detect belt loss and mechanical failure. Shall be Veris Hawkeye H908 or equal.

B. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.8 CURRENT TRANSDUCER (CT)

A. Clamp-On Design Current Transducer (for Motor Current Sensing):
   1. Range: 1-10 amps minimum, 20-200 amps maximum.
   2. Trip Point: Adjustable.
   3. Output: 0-5 VDC.
   4. Accuracy: +/- 0.2 percent from 20 to 100 Hz.
   5. Acceptable Manufacturers: KELE SA100.
2.9 NAMEPLATES
A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 inch thick, black, with white center core, and shall be minimum 1 inch x 3 inch, with minimum ¼ inch high block lettering. Nameplates for devices smaller than 1 inch x 3 inch shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

2.10 TESTING EQUIPMENT
A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/- 0.5 percent accurate, test equipment shall be +/- 0.25 percent accurate over same range).

PART 3 - EXECUTION

3.1 PREPARATION
A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION
A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.

D. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of the latest edition of the National Electrical Code and all local codes.

E. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.
1. Wiring System: Install complete wiring system for electric control systems. Conceal wiring exposed in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with the latest edition of the National Electrical Code and Division 26. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with the latest edition of the National Electrical Code and Division 26.

3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.

4. All WAN and LAN patch cords shall be approved and installed as directed by owner and shall be Cat 6A.

5. BAS low voltage wiring/cables: All cables shall have legible printed sleeve identification labels at each device and the panel termination.
   a. Labels shall be Brady PermaSleeve TM, part number - "BPSPT-187-175-WT" or approved equal.
   b. Each label shall be identified with the entire BAS point name.

6. Terminate all control wiring internal to panels to screw terminals connections or owner approved wire connection equivalent. Wire nuts and/or splices are not allowed in panels. When terminating a wire cable, the cable jacket, cable shielding wire, and cable shielding material shall be finished in a neat consistent workmanlike manner.

7. Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Install wiring in galvanized rigid steel conduit at all exterior locations and where subjected to moisture. Install in PVC Schedule 40 conduit if encased in concrete. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved fire/smoke sealant material to prevent migration of air through the conduit system.

8. Secondary LAN Communication cabling shall be provided in an Owner approved color dedicated to the BAS.

9. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

F. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

G. Averaging Temperature Sensors: Cover no more than two square feet per linear foot of sensor length except where indicated. Generally, where flow is sufficiently homogeneous/adequately mixed at sensing location, consult Engineer for requirements.

H. Airflow Measuring Stations: Install per manufacturer’s recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

I. Fluid Flow Sensors: Install per manufacturer’s recommendations in an unobstructed straight length of pipe.

J. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
K. Water Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

L. Pipe Surface Mount Temperature Sensors (Shall only be used where indicated on drawings or by written approval by owner): Install with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe Contractor shall neatly cut insulation install sensor, repair or replace insulation and vapor barrier and adequately seal vapor barrier.

M. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

N. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.

O. Supply Duct Pressure Transmitters:
   1. General: Install pressure tips with at least four (4) ‘round equivalent’ duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer’s installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
   2. VAV System ‘Down-Duct’ Transmitters: Locate pressure tips as required by current energy code and as shown on drawings.

P. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

### 3.3 DIGITAL CONTROL STATIONS, CONTROLLER QUANTITY AND LOCATION

A. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of this Specification.

B. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Contractor shall extend power to the DCS from an acceptable power panel. If the BAS provider wishes to further distribute panels to other locations, Contractor is responsible for extending power to that location also. Furthermore, Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.

C. Contractor shall locate DCS’s as referenced. It is the Contractor’s responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

D. Contractor shall provide a minimum of the following:
   1. One DCS (including at least one controller) in each chilled water/hot water plant mechanical room
   2. One DCS (including at least one controller) for each air handler located in applicable mechanical room
   3. One DCS (including at least one controller) for each critical fan system
   4. One DCS (including at least one controller) for each pumping system
   5. One controller for each piece of terminal equipment located at the equipment.
3.4 SURGE PROTECTION

A. Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.5 CONTROL POWER SOURCE AND SUPPLY

A. BAS Provider shall extend all power source wiring required for operation of all equipment and devices provided under Division 23 and the Drawings.

B. General requirements for obtaining power include the following:
   1. In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120v source fed from a common origin.
   2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment’s control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment’s control transformer is not large enough or of the correct voltage to supply the controls, provide separate transformer.
   3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served. Furthermore, the controller in that condition shall monitor each power type served to determine so logic can assess whether a failure is due to a power loss and respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.
   4. Provide an uninterruptible power supply (UPS) system battery backup for each controller or DCS. All panels shall be provided with full UPS power. UPS shall protect against blackouts, brownouts, surges and noise.
      a. UPS shall include LAN port and modem line surge protection.
      b. UPS shall be sized for a 7-minute full load runtime, 23-minute 1/2 load runtime, with a typical runtime of up to 60 minutes. Transfer time shall be 2-4 milliseconds.
      c. UPS shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90 percent recharge capability in 2-4 hours. Suppression response time shall be instantaneous. UPS low voltage switching shall occur when supply voltage is less than 94 volts.

3.6 BAS START-UP

A. No mechanical, electrical, or plumbing equipment shall be energized prior to controls being completely installed and functional.

3.7 OWNER TRAINING

A. Provide a minimum 40 hours of owner training. Owner training shall at a minimum include information on:
   1. Each controller type
   2. Graphics
3. Each equipment type
4. Modifications to graphics and backgrounds
5. Alarms
6. Sequences

END OF SECTION
SECTION 23 21 13
HYDRONIC PIPING AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Chilled-water piping.

B. Related Specifications
   1. Section 23 05 19, Meters and Gauges, for HVAC Piping for thermometers and gauges.
   2. Section 23 21 23, Hydronic Pumps, for pumps, motors, and accessories for hydronic piping.
   3. Section 23 21 16, Hydronic Specialties, for hydronic specialties.

1.2 SUBMITTALS
A. Product Data: For each type of the following:
   1. Pipe
   2. Fittings and accessories

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.3 QUALITY ASSURANCE
A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

B. Provide domestic manufactured piping and fittings.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Protect piping, valves, fittings, etc. before installation in accordance with manufacturer’s written instructions.

B. Piping shall be shipped from the factory with capped ends and stored on supports off the ground with ends covered at all times to prevent nesting of insects, birds, and other animals. Any pipe found to be without end-caps or not raised off of the ground should be cleaned by the contractor prior to installation.

C. Protect piping from accumulation of dirt and debris in and around piping/components.
1.5 **OPERATION AND MAINTENANCE DATA**

A. Operation and maintenance manuals shall include the following information:
   1. The approved submittal with all approved items present (not a partial resubmittal)
   2. Chemicals used in cleaning, flushing, inhibiting, and final water treatment.
   3. Water quality test reports from the cleaning process.

**PART 2 - PRODUCTS**

2.1 **STEEL PIPING AND FITTINGS**

A. 2 inches and less in diameter. ASTM A 53, Grade B, standard-weight seamless black steel pipe with standard-weight malleable iron threaded fittings, satisfying ASTM B16.3 and ASTM A 197

B. 2-1/2 inches to 10 inches in diameter. ASTM A 53, Grade B, standard-weight seamless or electric-resistance welded black steel pipe with standard-weight seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B16.9.

2.2 **JOINTS**

A. Screwed (Steel Piping, 2" and smaller):
   2. Apply suitable joint compound, such as Teflon tape to the male threads only.
   3. Ream pipe to full inside diameter after cutting. All-thread nipples are not permitted.

B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions.
   1. Provide insulating unions as manufactured by Crane, EPCO Sales, Inc. or approved equivalent.

C. Welded (Steel Piping, 2-1/2" and larger):
   1. Make welded joints as recommended by the standards of the American Welding Society.
   2. Ensure complete penetration of deposited metal with base metal.
   3. Provide filler metal suitable for use with base metal.
   4. Keep inside of fittings free from globules of weld metal.
   5. Do not use mitered joints.
   6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.

D. Flanged:
   1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.
   2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.
3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.

4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use galvanized steel nuts and bolts underground, coated with two coats of coal tar enamel. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.

5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105, Grade II or ASTM A 108, Grade II. Use welding neck type flanges at all fittings and on all pipe.

6. Flanges for ductile iron pipe are specified in sections using that pipe.

7. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.

### 2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8 inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and working temperatures and pressures.

### 2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Unions (for connecting to equipment where OEM connection provided is plastic):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. IPEX Inc.
      c. KBi.
      d. NIBCO INC.
   2. MSS SP-107, CPVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

### 2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
B. **Insulating Material:** Suitable for system fluid, pressure, and temperature.

C. **Dielectric Unions:**
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Central Plastics Company.
      d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
   2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180°F.

D. **Dielectric Couplings:**
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Calpico, Inc.
      b. Lochinvar Corporation.
   2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

### 2.6 UNIONS

A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

### 2.7 GASKETS

A. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.

B. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. Garlock or equal. For pipe smaller than 6 inches, use 1/16 inch thick gasket.

### 2.8 FLOOR AND CEILING PLATES

A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

### PART 3 - EXECUTION

#### 3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install valves according to the appropriate section.

N. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

O. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

P. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

Q. Identify piping as specified in the above referenced specification section.

R. Support piping adequately to maintain line and grade, with due provision for expansion and contraction.

S. Use only long radius elbows on steel and copper piping unless a short radius elbow is specifically shown on the drawings.
T. Slope condensate drain piping at a minimum 1/8 inch per foot in the direction of flow.

U. Provide dielectric union or flange at connections of dissimilar metals, including equipment connections.

3.2 WELDING

A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

B. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

C. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

E. Remove dirt, scale and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.3 OFFSETS AND FITTINGS

A. Because of the small scale of drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.

B. Install all piping close to walls, ceilings and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.

C. Install piping as to not obstruct any equipment or architectural access doors.

3.4 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment.

B. At air handling units, where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge and thermometer well and a balancing valve (with memory stop) for balancing, and valves for isolation of each coil. Refer to mechanical details for additional requirements.

3.5 DRAIN VALVES AND VENTS

A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained.
3.6 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, minimum 150 psig. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.8 PIPING APPLICATION SCHEDULE

A. Provide piping and fittings meeting the requirements of Part 2 as identified in the table below:

<table>
<thead>
<tr>
<th>Service</th>
<th>Pipe Sizes</th>
<th>Pipe Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water Piping</td>
<td>2&quot; and smaller</td>
<td>Steel</td>
</tr>
<tr>
<td>Chilled Water Piping</td>
<td>2-1/2&quot; and larger</td>
<td>Steel</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 23 21 23

HVAC PUMPS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section provides furnishing and installing the following hydronic pumps:
   1. Close Coupled Vertical In-Line Pumps

1.2 RELATED WORK
A. Section 23 00 10, Mechanical General Provisions.
B. Section 23 05 53, Mechanical Identification.
C. Section 23 07 16, Equipment Insulation.

1.3 REFERENCES
A. ANSI/UL 778 - Motor Operated Water Pumps.

1.4 PUMP SELECTION REQUIREMENTS
A. Select pumps conservatively for scheduled conditions. Furnish pumps which have reasonably high efficiencies, with peak efficiency at or near rated conditions. Select pumps that will operate stably at 15-foot suction lift despite substantial reduction in head or substantial increase in delivery.
B. Provide motor-driven pumps of the type and speed scheduled. Select pumps that are not overloaded throughout the entire range of pump operation. Provide pump connection sizes as scheduled.
C. If the pumps proposed are not considered suitable, submit manufacturer's data on other pumps, for review.

1.5 SUBMITTALS
A. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Clearly indicate which equipment and options are to be provided
B. Indicate pump's operating point on curves. Include NPSH curve when applicable.
C. Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
D. Submit information on electric motors per requirements and indicating compliance with Section 23 05 13. Motor data must be submitted with pump submittal. No exceptions.
E. Submit manufacturer's installation instructions under provisions of Section 23 00 10.
1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 10.

B. Include installation instructions, assembly views, lubrication instructions and replacement parts list.

C. Include copy of approved submittal, vibration test results and certified pump curve with final balancing point indicated.

D. Include letter of certification stating that pump was factory assembled by pump manufacturer.

1.7 EXTRA PARTS

A. Provide one extra set of mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products meeting all requirements of this specification section of the following manufacturers are acceptable
   1. Armstrong Pumps
   2. Bell & Gossett
   3. Taco
   4. Grundfos/Paco

2.2 CLOSE COUPLED VERITCAL IN-LINE PUMP

A. Description: Factory assembled and tested single stage vertical in-line close coupled pump with integrated or stand-alone intelligent controls.

B. Casing:
   1. Cast Iron with 125 psig ANSI flanges for working pressure below 175 psig at 150°F. Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.
   2. Provide stainless steel nameplates and other data plates suitably secured to the pump.

C. Impeller: stainless steel 316, fully enclosed type. Dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.

D. Shaft: Furnish close coupled stainless steel shaft, turned and ground to accurate dimension, of ample size to prevent deflection.

E. Mechanical Seals: Shall be Stainless Steel spring rated to 200F. The rotating face shall be constructed of resin bonded carbon, and the stationary face shall be sintered silicon carbide. The shaft seal elastomer shall be EPDM.
F. Name Plates. Nameplates and other data plates shall be stainless steel, suitably secured to the pump. Provide one spare stainless steel performance nameplate with each pump that is insulated and field install to be visible after pumps are insulated.

2.3 MOTORS

A. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation.

B. Motor shall be ECM type housed in a TEFC enclosure and shall be IE4 efficiency, or better.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer's printed recommendations and pipe as shown on drawings. Install pumps with access (minimum 2'-6") for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Stored pumps shall have shafts rotated at least once a month.

D. Name Plates: Install spare nameplate as required in Part 2 of this Specification.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install pipe supports, and other devices as shown on the detail.

F. Connect wiring according to Section 26 05 19, Insulated Conductors.

3.3 VIBRATION TESTING

A. Vibration velocity readings shall be taken at all bearing locations of all pumps. Pumps driven by variable speed motors shall be tested throughout their range of speeds. Vibration shall not exceed 0.15 inch/second (peak). Record and deliver copies of the test report to the Owner and include report in the O&M Manual.

END OF SECTION
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SECTION 26 00 00

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

   A. Provide labor, materials and equipment required for complete and functioning electrical systems as required by the contract documents.

   B. New Work. The work includes, but is not limited to, the following principal systems and equipment:
      1. 480/277 volt distribution.
      2. 208/120 volt distribution.
      3. Panelboards-Distribution, Branch Circuit and Electronic Grade.
      4. Grounding and bonding system.
      5. Motor controllers.

   C. Demolition. Refer to demolition Drawings and Section 26 01 00 for scope of work.

1.2 APPLICABLE PROVISIONS

   A. Provisions Specified Elsewhere. Unless modified in this Section, General and Supplementary General Conditions, applicable provisions of Division 01 - General and other provisions of contract documents apply to work of Division 26 - Electrical.

   B. Application. Provisions of this Section apply to every section of Division 26 - Electrical, except where specifically modified.

   C. Work covered by this Section shall be accomplished in accordance with applicable provisions of the Contract Documents and addenda or directives which may be issued herewith, or otherwise.

1.3 RELATED WORK

   A. Existing Conditions - Division 02.

   B. Site Work – Division 02.

   C. Concrete - Division 03.

   D. Sealing and Firestopping – Division 07.

   E. Openings - Division 08.

   F. Finishes - Division 09.
G. Equipment - Division 11.

H. Furnishings – Division 12.

I. Special Construction – Division 13.


L. Plumbing – Division 22.

M. Heating, Ventilation and Air Conditioning – Division 23.

N. Communications – Division 27.


P. Utilities – Division 33.

1.4 REFERENCE CODES AND STANDARDS

A. Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

B. Association of Edison Illuminating Companies (AEIC).

C. American National Standards Institute (ANSI).

D. Institute of Electrical and Electronics Engineers (IEEE).

E. Insulated Cable Engineers Association (ICEA).

F. National Electrical Code (NEC).

G. National Electrical Manufacturers Association (NEMA).


I. National Fire Protection Association (NFPA).

J. Underwriters’ Laboratories (UL).


1.5 REGULATIONS AND PERMITS

A. Regulations. Work, materials and equipment must comply with the latest rules and regulations of the following:


3. Occupational Safety and Health Act (OSHA).
4. Americans with Disabilities Act (ADA).
5. Texas Department of Licensing and Regulation (TDLR).
8. State and federal codes, ordinances and regulations.

B. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing, including a proposed resolution, and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.

C. Permits: Obtain certificates of inspection and other permits required as a part of the work. Submit written evidence to the Owner's Representative and Architect/Engineer that the required permits and inspections have been secured.

1.6 DRAWINGS AND CONTRACT DOCUMENTS

A. Intent: The intent of the construction Drawings or contract documents, hereinafter referred to as the “Drawings”, is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. The Drawings, specifications, and related contract documents are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Electrical Drawings, are generally diagrammatic and show approximate location and extent of the work. Review pertinent Drawings and adjust the work to conditions shown. Install the work complete, including minor details necessary to perform the function indicated.

B. The Contractor shall carefully investigate structural and finish conditions, and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceways, subject to prior review by the Owner's Representative. Work shall be organized and laid out in finished portions of the building so that it will be concealed in furred chases, suspended ceilings, and similar elements of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

C. Discrepancies: In case of doubt as to work intended, or if amplification or clarification is needed, or where discrepancies occur between Drawings, specifications, and actual field conditions, immediately notify the Architect/Engineer and the Owner's Representative in writing, requesting an interpretation, and include a proposed solution.

D. Dimensions: Dimensional information related to new structures shall be taken from the appropriate Drawings. Dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
E. Outlet and Equipment Locations: Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical, telecommunications, audio-visual (AV), security, plumbing, and laboratory Drawings. Review with the Owner’s Representative proposed changes in outlet and equipment location. Relocation of outlets before installation of up to 5 feet from the position indicated may be directed without additional cost to the Owner. Remove and replace outlets placed in unsuitable locations, when so requested by the Owner’s Representative, and at no additional cost to Owner.

1.7 SUBMITTALS

A. Submit the following in addition to and in accordance with the requirements of the Uniform General Conditions and in Division 01, Submittals.

1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
2. Manufacturer’s standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions are clearly indicated, and non-applicable portions clearly deleted or crossed out.
3. Schematic, connection and/or interconnection diagrams.
4. Provide submittals as required by individual specification section.

B. Provide the following with each submittal:

1. Catalog cutsheets with manufacturer’s name clearly indicated. Applicable portions shall be clearly indicated by arrows, circles, or similar markings and non-applicable portions shall be clearly deleted or crossed out.
2. Line-by-line specification review by equipment manufacturer and contractor with exceptions explicitly defined.
3. Itemize and organize equipment and material submittals by specification Section number; include manufacturer and identifying model or catalog numbers.
   a. Submittal packages for product data, shop drawings, and other required submittals shall be numbered sequentially according to the applicable specification Section number. For example, the first submittal package for Energy-Efficient Dry-Type Transformers shall be identified as Submittal number 262213-01. The second submittal package for Energy-Efficient Dry-Type Transformers would be identified as Submittal number 262213-02. Re-submittal packages shall be identified by an “R” in the sequential numerical suffix.
   b. Where directed by the Owner or the Architect to combine submittals into a common package, the submittal data may be organized in one or more 3-ring binders or similar container. Product data, shop drawings, and other submittal data shall be organized in separate tabs according to paragraph 1.07B.3a, above. That is, submittal data in individual tabs of a common submittal package shall be numbered sequentially, according to the applicable specification Section number.
4. Replace rejected items and resubmit with acceptable items in accordance with the requirements of Division One for Submittals, and with the Uniform General Conditions.

C. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.

1. Itemize equipment and material by specification section number; include manufacturer and identifying model or catalog numbers.
2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
3. If a satisfactory replacement is not submitted within a two-week period, Owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to Owner.

D. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads shall be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.

E. Alternate paragraph: Where coordination or shop drawings are not desired to be submitted for approval in Part 1. Omit paragraph 1.07E and 1.07F and use alternate paragraph 3.03A in Part 3.

F. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also submit the following for review:

1. Electrical and Telecommunications Rooms. Submit 1/4-inch scale coordination drawings of electrical and telecommunications rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

2. Mechanical and Pump Rooms. Submit 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

3. Auditorium, Lecture, Conference and Audio-Visual (A/V) Rooms. Submit 1/8-inch scale coordination drawings showing receptacles, snap switches, occupancy sensors, lighting controls, dimmers, communication outlets, and Audio-Visual (AV) outlets and devices (including projector mounts). Indicate locations and mounting heights of outlets and devices. Electrical, communication and AV devices shown in proximity to each other shall be grouped.

4. Corridors. Submit 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.
5. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.

6. Review: The completed “Composite Drawings” shall be submitted to the Architect/Engineer for review prior to installation. Work that proceeds without appropriate coordination and review will be subject to removal and relocation at no additional cost to the Owner.

G. Installation: Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by Owner’s Representative. Use only equipment and materials accepted by the Architect/Engineer and by Owner’s Representative. Equipment and materials installed prior to acceptance by the Owner/Engineer and Owner’s Representative shall be removed at no additional cost to Owner and replaced at the Contractor’s expense.

H. Alternate paragraph: Where startup and test procedures are not desired to be submitted for approval in Part 1. Omit paragraph 1.07G and use alternate paragraph 3.03B in Part 3.

I. Startup and Test Procedures:
1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.
4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

J. As-Built and Record Drawings:
1. Maintain a master set of as-built drawings that show changes and other deviations from the Drawings. The markups shall be made as the changes are done. The markups shall show the actual changes and shall not reference RFI’s, ASI’s etc. The record drawing shall be a complete standalone document clearly showing all changes that differ from the design drawings. Any references to RFI’s, ASI’s etc. will result in a rejection of the record drawings.
2. At the conclusion of the project, these as-built drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner’s Representative, and shall be complete.
3. Prior to final acceptance, deliver to the Owner’s Representative the AutoCAD electronic files, the complete set of record drawings showing the as-built condition of the project, and the actual field set of as-built drawings. Also deliver one set of as-built drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).
4. Quantity: In accordance with the requirements of Division One and the General Conditions. Where not specified elsewhere, provide 3 hard copies plus one reproducible set.
K. Operating and Maintenance Manuals: As specified in Part 3 of this Section and in Division One, as applicable.

L. Overcurrent Protective Device Coordination Study: Provide preliminary and final study as specified in Section 26 05 73. Make adjustments to materials and submittals under other Sections of Division 26 as required and as recommended by the Overcurrent Protective Device Coordination studies.

1.8 SUBSTITUTIONS

A. Refer to requirements of Division One for substitution of Material and Equipment.

B. Product manufacturers are listed to establish a level of quality for the products. Substitutions may be allowed if the product is equal to or better than what is listed in the design guidelines, as determined by the Architect/Engineer and owner’s Representative upon submittal of comparison products.

C. Samples: When requested by the Owner’s Representative or the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. When requested, provide samples of both the specified item and the proposed item for comparison purposes.

D. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. Time periods for Architect/Engineer processing and review of submittal data, shop drawings, samples, studies, and reports shall be in accordance with the applicable submittal and substitution requirements of Division One and the General Conditions. The Contractor shall allow sufficient time for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles for processing of submittal data and shop drawings, including time for resubmittal cycles on unacceptable and rejected materials, equipment, components, and systems covered by the data submitted. Construction delays and lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in requests for scheduled construction time extensions and additional costs to the Owner.

E. Acceptance: Acceptance of materials and equipment will be based on manufacturer’s published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the Drawings, specifications, and other applicable Contract Documents, and that adequate and acceptable clearances will exist for entry, servicing, and maintenance. Acceptance of materials and equipment under this provision shall not be construed as authorizing deviations from the Specifications, unless the attention of the Owner’s Representative and the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless pertinent information is properly identified.

F. Replacement; should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment originally specified at no additional cost to the Owner.
1.9 CONTRACTOR QUALIFICATIONS

A. An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system.
   1. The Contractor may be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 3 years. The superintendent must have had experience in installing not less than three such systems.
   2. The Contractor must have personnel with the proper licenses to perform electrical work under this Contract. In accordance with the Texas Electrical Safety and Licensing Act – Title 8, Occupation Code, Chapter 1305, Subchapter D, section 1305.151: “LICENSE REQUIRED. Except as provided by Section 1305.003, a person may not perform electrical work unless the person holds an appropriate license issued or recognized under this chapter.”

B. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of the Project Safety Manual (PSM).
   1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.
   2. The Contractor shall secure electrical rooms, to limit access, prior to energizing high voltage (1000V or higher) equipment, and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is ongoing near energized equipment. The Contractor shall cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.
   3. The Contractor shall strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

1.10 TEMPORARY CONSTRUCTION SERVICE

A. The contractor is responsible for coordinating construction power per the Owners Special Conditions.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Condition. Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.

B. NEC and UL.
   1. Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products and issued labels, products used must be listed and labeled by UL.
   2. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Where no specifications or specific model numbers are given, provide materials of a standard industrial quality.
C. **Space Limitations:** Equipment selected must conform to the building features and must be coordinated with them. Electrical installation shall comply with the requirements of Article 110.26 and Article 110.34 of the National Electrical Code (NEC) for working space, access, and dedicated equipment space. Do not provide equipment that will not suit arrangement and space limitations. Scaled drawings (1/4” = 1'-0") of electrical and telecommunication rooms shall be submitted for review by the Architect/Engineer and the Owner’s Representative prior to installing equipment. See paragraph 1.07E above.

D. **Factory Finish.** Equipment shall be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.

E. **Physical Size of Equipment:** Equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless the Contractor demonstrates by product data, shop drawings, and coordination drawings that ample space exists for proper installation, operation, and maintenance.

F. **Enclosure:** Provide NEMA 1 enclosure for indoor installation and NEMA 3R for outdoor enclosure, unless noted or specified otherwise. The enclosure shall be suitable for the environment per NEC, NEMA and ANSI standards.

G. **Conductors in Conduit:** Conductors shall be installed in conduit. Exceptions are listed in individual Sections of the Division 26 and Division 28 specifications.

H. **Non-Ferrous:** Use non-ferrous materials in rooms with equipment employing magnetic equipment with elevated gauss fields, such as Nuclear Magnetic Resonance (NMR) and Magnetic Resonance Imaging (MRI) equipment. Use non-ferrous materials where gauss fields extend into adjacent spaces, and other locations as indicated on Drawings.

### 2.2 MANUFACTURER

A. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer, except as specifically noted in individual Sections of the specifications.

B. **Common Source:**
   1. Generator, Automatic Transfer Switches, and Bypass-Isolation Switches: Equipment specified in Sections 26 32 14, 26 36 23, and 26 36 25 shall be provided by the same supplier, and shall be the responsibility of the supplier for the packaged electric generating plant. Responsibility for warranty service shall not be a justification for substitution of products of a manufacturer other than those listed for equipment in the individual Sections 26 32 14, 26 36 23, and 26 36 25.

### 2.3 SUBSTITUTIONS

A. Refer to Division 01 section on Material and Equipment, and to paragraph 1.08 of this Section.

### 2.4 NAMEPLATES AND DEVICE MARKING

A. Refer to Section 26 05 53, Identification For Electrical Systems.
2.5 AUTOMATED EQUIPMENT AND CONTROLS

A. Equipment and control systems where applicable, shall match, integrate, communicate and cooperate with new and existing systems, such as building automation, energy management, direct digital controls (DDC), fire detection and alarm, circuit breakers, transformers, etc.

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturer’s Recommendations: The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, wiring, and connection of equipment and material. Promptly notify the Architect/Engineer and the Owner’s Representative in writing of conflicts between the requirements of the Drawings and specifications and the manufacturer’s directions, in accordance with paragraphs 1.05B and 1.06C of this Section. Obtain instructions from the Owner’s Representative before proceeding with the work. Should the Contractor perform work that does not comply with the manufacturer’s directions or such instructions from the Owner’s Representative, he shall bear costs arising in connection with the deficiencies.

B. Site Observation: Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Drawings, specifications, and other applicable Contract Documents. Site observation by the Architect/Engineer shall not be construed as construction supervision, or indication of approval of the manner or location in which the work is being performed, or as being a safe practice or place. Site observation by the Architect/Engineer shall not be construed as inspection by the Authority Having Jurisdiction (AHJ) or other applicable code enforcement authority.

C. Installation: Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by the Owner’s Representative. Use only equipment and materials accepted by the Architect/Engineer and the Owner’s Representative. Equipment and materials installed prior to acceptance by the Architect/Engineer and Owner’s Representative shall be removed at no additional cost to Owner and replaced at the Contractor’s expense.

D. Supervision:
1. The Contractor of the work under this Division shall keep a competent superintendent or foreman on the job throughout the period of construction. Refer to Division One requirements and the Uniform General Conditions for additional information concerning supervision.
2. It shall be the responsibility of such superintendent to study the Drawings, specifications, and other applicable Contract Documents, and familiarize himself with the work. He shall coordinate his work with other trades before material is fabricated or installed, and ensure that his work will not cause interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the Contractor. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the Architect/Engineer and the Owner’s Representative for resolution in accordance with paragraphs 1.05B and 1.06C of this Section.
3.2 PROTECTION OF EQUIPMENT AND MATERIALS

A. General:
1. The Contractor shall follow the manufacturer’s directions completely in the delivery, storage and handling of equipment and materials.
2. Equipment and materials shall be tightly covered and protected against dirt, water, chemical, physical or weather damage and theft. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and shall be returned to “as new” condition.
3. Electrical cable, wire, and conductors shall be stored to prevent moisture and mechanical damage.

B. Moisture. During construction, protect switchboard, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually.

C. Clean. Keep products clean by elevating above ground or floor and by using suitable coverings.

D. Damage. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

E. Finish. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore finishes that become stained or damaged.

F. Weather. Protect equipment and materials from weather and sunlight by use of suitable coverings and storage indoors, or in suitable weather-protected containers. Materials and equipment marked by their manufacturer as suitable for storage outdoors may be stored according to manufacturer’s markings. Maintain factory-installed coverings and wrappings until material is to be installed.

3.3 PREPARATION

A. Alternate paragraph where coordination or shop drawings are not desired to be submitted for approval in Part 1. Omit paragraph 1.07E and 1.07F above.

B. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also prepare the following:
1. Electrical and Telecommunications Rooms. Prepare 1/4-inch scale coordination drawings of electrical and telecommunications rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

2. Mechanical and Pump Rooms. Prepare 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

3. Auditorium, Lecture, Conference and Audio-Visual (A/V) Rooms. Prepare 1/8-inch scale coordination drawings showing receptacles, snap switches, occupancy sensors, lighting controls, dimmers, communication outlets, and Audio-Visual (AV) outlets and devices (including projector mounts). Indicate locations and mounting heights of outlets and devices. Electrical, communication and AV devices shown in proximity to each other shall be grouped.

4. Corridors. Prepare 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.

5. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.

6. Review: The completed "Composite Drawings" shall be prepared prior to installation. Work that proceeds without appropriate coordination will be subject to removal and relocation at no additional cost to the Owner.

C. Alternate paragraph where test procedures are not desired to be submitted for approval in Part 1. Omit paragraph 1.07G above.

D. Test Procedures:
1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.
4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.
3.4 SAFETY

A. Implement the following safety procedures in addition to, and in accordance with, the requirements of Division One and the Uniform General Conditions:
   1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel of hazards particular to this project and update the information as the project progresses.
   2. Prior to energizing panelboards within the scope of work, secure affected electrical rooms to limit access to line voltage. Line voltage shall be defined as above 50 volts, for the purpose of controlling access. During and after energization of panelboards, control access to electrical rooms for the duration of the project. Post and maintain warning and caution signage in areas where work is on-going near energized equipment. Cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.
   3. Strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

3.5 INSPECTION

A. Examination. Examine the areas and conditions under which equipment and systems are to be installed, and notify the Owner’s Representative in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Coordination. Carefully investigate structural and finish conditions and coordinate the work in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, suspended ceilings, and similar elements in finished portions of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

3.6 INSTALLATION

A. Cooperation with Other Trades. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades. Provide other trades, as required, templates, patterns, setting plans and shop details for the proper installation of the work and for purposes of coordinating adjacent work. Electrical power connections for mechanical and plumbing equipment are in this Division unless noted otherwise. Verify electrical characteristics of equipment with other Divisions before roughing in the electrical connections.

B. Workmanship. Work shall be performed by workmen skilled in their trade. The installation shall be complete and installed in a neat and workmanlike manner in accordance with NEC 110.12 and FPM accompanying, and as described in ANSI/NECA 1-2000 “Standard Practices for Good Workmanship in Electrical Contracting”, and other ANSI approved installation standards.

C. Concrete Equipment Pads.
   1. Refer to structural Drawings and specifications for design criteria.
2. Where not otherwise indicated, install 3-1/2 inch thick concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. For equipment mounted outdoors, provide concrete foundations a minimum of 6 inches above grade. Provide reinforcing steel as recommended by the structural engineer and as detailed on the Drawings. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.

3. Anchor Bolts. Furnish and install galvanized anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.

4. Setting of Equipment. Provide permanent and temporary shoring, anchoring, and bracing required to make parts stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.

   1. Equipment must be leveled and set plumb.
   2. Sheet metal enclosures mounted against a wall shall be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers, or by 3 inches of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment.
   3. In sufficient time to be coordinated with work under other divisions, provide shop drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
   4. Provide adequate support for freestanding panels, switchboards, enclosures, and other equipment. This shall include bolting to the floor, concrete equipment pad, or solid structural steel to prevent tipping. Install free-standing electrical equipment on concrete equipment pads in accordance with paragraph 3.05C, this Section, except where equipment is noted and designed for mounting directly on the concrete floor slab. Under no condition shall equipment be fastened to non-rigid building steel such as removable platform steel gratings, handrails, etc.
   5. Provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. Do not mount or suspend equipment from supports provided for equipment and systems by other Divisions, except where specifically noted or indicated on Drawings.
   6. Refer to Section 26 05 29, Metal Framing and supports, for additional requirements.

E. Sealing of Equipment. Seal openings into equipment to prevent entrance of animals, birds and insects, as well as to prevent ingress of moisture, dust, dirt, and similar contaminants.

F. Motors.

   1. Motors are specified in Divisions 21, 22 and 23.
   2. Electrical work includes the electrical connection of motors, except those which are wired as a part of equipment.
   3. Refer to Division 23 and other applicable Divisions for wiring and connection of motors and equipment furnished by those Divisions.
4. The Contractor shall note that the electrical Drawings are based on the equipment scheduled and indicated on the Drawings. Should mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

5. Provide interconnecting wiring for the installation of the power required. Provide disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. Combination starters, individual starters, and other motor starting apparatus, not specifically scheduled or specified as provided by the equipment manufacturer under the scope of other Divisions shall be provided under the scope of Division 26.

6. Other Divisions will provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review. Diagrams will be based on accepted equipment and be complete full phase and interlock control drawings, not a series of manufacturer’s individual diagrams. They will be followed in detail. For additional clarification, refer to Division 23, Controls.

G. Concealed Work. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:
   1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
   2. Where exposure is necessary to the proper function.
   3. Where size of materials and equipment preclude concealment. Obtain the written consent of the Owner’s Representative and the Architect/Engineer to leave materials exposed in finished spaces of the building.

H. Application. Unless otherwise indicated, power will be utilized as follows:
   1. 480 volts, three phase: motors 3/4 horsepower and larger.
   2. 120 volts, single phase: motors 1/2 horsepower and smaller.
   3. 277 volts, single phase: fan powered boxes.
   4. 120 volts, single phase: incandescent lighting.
   5. 277 volts, single phase: fluorescent and high-intensity-discharge lighting.
   6. 120 volts, single phase: convenience outlets, dedicated equipment, lab-track terminal boxes without fans.
   7. 208 volts, single and three phase: specialty outlets.
   8. 480 volts, three phase: special power and equipment; verify for each unit of equipment.

I. Transformers. Use transformers to change the service to the required utilization voltages.

J. Connections to Equipment - Other than Division 26. For equipment furnished under other Divisions, and for equipment furnished by the Owner, provide final electrical connections to such items of equipment. Obtain detailed shop drawings of equipment from the applicable Division or supplier indicating the exact number and location of rough-in points. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the work required.
   1. Roughing-in: When roughing-in, provide electrical branch circuits to various items of equipment. Terminate at proper points as indicated on detailed equipment shop drawings, or as directed. Use Drawings accompanying these specifications only for general routing of circuiting. Do not use Drawings accompanying these specifications for rough-in locations.
2. Final Connections: Millwork, casework, and similar equipment will include service fittings such as switches, duplex receptacles, data/communications outlets, and luminaires on the casework or equipment. Provide branch circuit connection to match electrical connection requirements of service fittings.

K. Accessories. Offsets, fittings, expansion joints, anchors and accessories that are required for a complete system shall be provided, even if not specifically indicated on the Drawings or mentioned in the specifications. Offsets, transitions and changes in direction of conduit, cable trays, raceways and busways shall be made to maintain proper headroom. Provide pullboxes, fittings, etc., required as a result of these transitions and changes in direction.

L. Observation prior to cover-up or seal-in of walls and ceilings. Perform the following in accordance with the applicable requirements of Division One and the General Conditions:

1. Prior to the installation of ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner’s Representative so that arrangement can be made for observation or inspection of the above-ceiling area about to be “sealed” off. The Contractor shall provide advance notice in accordance with the applicable requirements of Division One and the General Conditions. Where not specified, required, or directed elsewhere, provide not less than 10 working days’ advance notice.

2. Above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. Electrical work at and above the ceiling, including items supported by the ceiling grid, shall be complete and installed in accordance with contract requirements, including power to luminaires, fans, and other powered items. The purpose of this inspection is to verify the completeness and quality of the installation of the electrical systems and other above ceiling special systems such as cable tray systems. The ceiling supports shall be in place so that access panel and luminaire locations are identifiable, and so that clearances and access provisions may be evaluated.

3. No ceiling materials may be installed until the resulting deficiency list from this inspection is completed and approved by the Owner’s Representative.

M. Finish. Coordinate with Division 9 to paint exposed conduit to match adjacent walls, unless otherwise directed.

3.7 EXISTING FACILITIES

A. Responsibility. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and maintenance of electrical services for new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing such temporary protection upon completion of the work.

B. Services. The Contractor shall provide temporary or new services to existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Access. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, luminaries, air conditioning ductwork and equipment, etc., to provide this access, and shall reinstall same upon completion of work in the areas affected.
D. Existing Devices. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, remove and reinstall in locations approved by the Architect/Engineer devices required for the operation of the various systems installed in the existing construction. This is to include, but is not limited to, temperature controls, system devices, electrical switches, relays, luminaires, fixtures, piping, conduit, etc.

E. Outages. Outages of services as required by the new installation will be permitted, but only at a time approved by the Owner. The Contractor shall coordinate with the Owner’s Representative to arrange for service outages. The Contractor shall allow the Owner sufficient time to schedule for required outages, in accordance with the applicable requirements of Division One and the General Conditions. Where not specified, required or directed elsewhere, allow a minimum of 21 working days for the Owner to schedule for required outages. The time allowed for outages will not be during normal working hours or during hours of research and instruction, unless otherwise approved by the Owner’s Representative. Costs of outages, including overtime charges, shall be included in the contract amount.

F. Adjacent Facilities. Coordinate work among the various trades to minimize disruption to existing processes, procedures, and equipment in spaces adjacent to areas of demolition and renovation work. Coordinate with Owner’s Representative to schedule work producing noise or structure-born vibrations, including but not limited to cutting, drilling, coring, and use of impact tools.

G. Refer to Section 26 00 02, Demolition, for additional requirements.

3.8 EQUIPMENT AND DEVICE MARKING

A. Designations. Identify equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the Drawings.

B. Nameplates. Externally mark electrical equipment with nameplates identifying each and the equipment served. Supply blank nameplates for spare units and spaces.

C. Refer to Section 26 05 53 for additional requirements.

3.9 SLEEVES, PENETRATION, CUTTING AND PATCHING

A. General. Cut and patch walls, floors, etc., resulting from work in existing construction. Provide for the timely placing of sleeves for raceway and exposed cabling passing through walls, partitions, beams, floors and roof while same are under construction. If openings, sleeves, and recesses are not properly installed and cutting and patching become necessary, it shall be done at no expense to the Owner. Secure permission from the Owner’s Representative before cutting or patching a constructed or existing wall. Where roofs or walls are fire rated, penetrations shall be completely sealed using UL-listed materials and procedures sufficient to preserve the fire rating. Comply with special requirements of local authorities.

B. Structure. Do not cut or core through structural beams, joists, load-bearing walls, grade beams, or similar load-bearing structure. Where limited space is available above the ceilings below concrete beams or other deep projections, notify the Owner’s Representative in writing, including a proposed solution, and request a resolution. Approval shall be obtained from the Owner’s Representative and the Architect/Engineer for each penetration.
C. Penetrations.
1. This contract requires core drilling of floor or wall penetrations as indicated on Drawings. Core drilling shall be in accordance with structural specifications. Floor penetrations shall include a sleeve that extends above the floor 2 inches, except where plugs and caps are specified or indicated flush with floor or foundation pad. Electrical penetrations shall be coordinated with structure during design, and shall be made in compliance with structural requirements specified in the structural Drawings and specifications. Field modifications are required to be reviewed and approved by structural engineer prior to installation.
2. Penetrations shall be sealed in accordance with the requirements of Division 7, Firestopping. Coordinate with Division 7 to provide firestopping systems and materials that are compatible with the penetrations for systems and equipment furnished and installed under Division 26.
3. Provide sleeves for conduit penetrations of smoke, fire, and sound rated partitions. Install sleeve with a minimum of 1 inch diameter where penetrating the exterior drywall.
4. Provide proper sizing of sleeves or core-drilled holes to accommodate their through-penetrating items. In general, provide conduit sleeves two standard sizes larger than their through-penetrating items. Provide larger sleeves as required to allow passage of couplings for through-penetrating items.

D. Sealing and Firestopping.
1. Voids between sleeves or core-drilled holes and pipe passing through fire-rated assemblies shall be firestopped to meet the requirements of ASTM E 814, in accordance with Division 7 requirements for Firestopping.
2. Where the routing of cable tray passes through fire-rated walls, floors or other fire-rated boundaries, coordinate with Division 7 to provide removable firestopping system.
3. Furnish and install UL Systems Classified, intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250°F, for the sealing of holes or voids created to extend electrical systems through fire rated floors and walls, in order to prevent the spread of smoke, fire, toxic gas or water.
4. Fire barrier products shall be used to create through-penetration firestop systems as required. Firestop systems shall be listed in the Underwriter’s Laboratories Building Materials Discovery, Through Penetration Firestop Systems (XHEZ).
5. Install firestop materials and systems according to their UL Systems Classifications, manufacturer instructions, manufacturer recommendations, and the requirements of applicable Division 7 specifications.

E. Conduit Sleeves. Conduit sleeve shall be two standard sizes larger than the size of conduit it serves, except where “Link Seal” casing seals are used in sleeves through walls below grade. Sleeves in floor shall extend a minimum of two inches above the finished floor. Conduit passing through concrete masonry walls above grade shall have 18-gauge galvanized steel sleeves. Sleeves set in concrete floor construction shall be at least 16-gauge galvanized steel. Sleeves set in concrete floor construction supporting conduit risers shall be standard weight galvanized steel. Sleeves supporting conduit risers 3 inches and larger shall have three 6 inch long reinforcing rods welded at 120 degree spacing to the sleeve, and shall be installed embedded in the concrete or grouted to existing concrete. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve. Seal around penetrations through sleeving as indicated under firestopping as specified herein, and in compliance with the requirements of Division 7 specifications. Galvanized steel requirements can be omitted where not supporting conduits.
F. Penetrations Below Grade. Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be two inches wider in radius than the sleeve it encircles. The entire assembly shall be hot-dipped galvanized after fabrication. Seal off annular opening between conduit and sleeve with “Link Seal” casing seal as manufactured by Thunderline Corporation of Wayne, Michigan. Size conduit sleeve to accommodate the casing seal. Use Series 300 casing seals for pipe 3/4-inch through 4-inch and Series 400 casing seals for pipe sized 5-inch and larger.

G. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and core drills, and at such locations acceptable to the Owner's Representative. Impact type equipment shall not be used except where specifically accepted by the Owner's Representative. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.

H. Restoration. Restore openings to “as new” condition under the appropriate specification Section for the materials involved, and match remaining surrounding materials and/or finishes.

I. Masonry. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Provide adequate supports during the cutting operation to prevent damage to the masonry caused by the cutting operation. Structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner’s Representative.

J. Structure. No cutting, boring, or excavating which will weaken the structure shall be undertaken. Coordinate with structure for placement of conduit, sleeves, and the like through beams, joists, slabs, mats, and other structural components and systems prior to forming of those structural components and systems.

K. Watertight. Where sleeves pass through roof or floors requiring waterproof membrane, lead flashing with a density of at least three pounds per square foot shall be built into the membrane a minimum of six inches to provide a watertight installation. Provide other watertight installation materials as detailed on the Drawings and as specified under Division 7 – Roofing.

L. Escutcheons. Provide heavy chrome-plated or nickel-plated plates on conduit passing through walls and ceilings in finished areas. Escutcheons shall be B&C No. 10, or accepted substitution, chrome-plated steel plates with concealed hinges.

M. Roof Penetrations and Flashings. Furnish and install pipe, conduit and duct sleeves, and flashing compatible with the roofing installation for roof penetrations. Coordinate with Division 7.

3.10 CLEANING, ADJUSTING AND START-UP

A. Cleaning. Clean electrical equipment, components, and devices prior to installation of final finish or covers, prior to startup and testing, prior to final observation by Architect/Engineer and Owner’s Representative, and as required under individual Sections of the Division 26 specifications.

B. Adjusting. Adjust equipment, devices, and systems as specified under individual Sections of these Specifications and in accordance with manufacturer’s instructions for proper functioning during modes of operation, including emergency and shutdown conditions.
C. Factory Authorized Representative. Where specified for an individual item of electrical equipment, provide a factory authorized representative for adjustment, start-up, and testing of equipment, and instruction of Owner’s operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

3.11 TESTING

A. Test Conditions. Use field startup and testing procedures submitted in accordance with paragraph 1.07H of this Section and accepted by the Owner’s Representative and the Architect/Engineer. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.

B. Alternate paragraph where test procedures are not desired to be submitted for approval in Part 1

C. Test Conditions. Use field startup and testing procedures prepared in accordance with paragraph 3.03B of this Section. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.

D. Test Dates. Schedule final acceptance tests sufficiently in advance of the contract completion date to permit adjustment and alterations within the number of days allotted for completion of the contract. Inform the Owner’s Representative in advance of test dates in accordance with the applicable requirements of Division One and the General Conditions. Where not specified, required, or directed otherwise, allow a minimum of at least 10 working days advance notice.

E. Retests. Conduct retests as directed by the Owner’s Representative of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Delays resulting from retests do not relieve the Contractor of his responsibility under this contract.

F. Commissioning. Coordinate with commissioning agent, as applicable, for field testing and commissioning of electrical components and systems.

G. Test Reports. Submit copies of test reports to the Architect/Engineer in accordance with Division One requirements.
3.12 OPERATING AND MAINTENANCE MANUALS

A. General. The Contractor shall provide, in loose-leaf binders, complete operating and maintenance data of each manufactured item of equipment used in the electrical work at least four weeks before Architect/Engineer's final review and observation of the project. Descriptive data and printed installation, operating and maintenance instructions for each item of equipment will be included. A complete double index will be provided as follows.

B. Format and content. The Operating and Maintenance Manual will be submitted in quantities and format as specified under Division One for Submittals. Provide quadruplicate where quantity is not specified. Operating and Maintenance Manual shall include:

1. Descriptive data of each system and piece of equipment, including ratings, capacity, performance data, operating curves and characteristics, and wiring diagrams.
2. Full detailed spare parts list, including source of supply for each piece of equipment.
3. Printed instructions describing installation, operation, service, maintenance, and repair of each piece of equipment.
4. Typewritten test reports of tests made of materials, equipment and systems under this Division. Test reports will include the dates of the tests, name of person conducting and witnessing the tests, and record of conditions relative to the tests.
5. Copies of "Reviewed" shop drawings and submittals.
6. Print copies of the record Drawings. Refer to paragraph 1.07I of this Section.

END OF SECTION
SECTION 26 05 19
INSULATED CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section specifies the furnishing and installation of insulated conductors.

1.2 REFERENCE STANDARDS
B. ANSI/UL 83 - Thermoplastic-Insulated Wires and Cables.
C. IEEE No. 48 - Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.
D. ICEA S-61-402 (NEMA WC 5) - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
E. ICEA S-68-516 (NEMA WC 8) - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
F. ANSI/UL 2196 "Tests for Fire Resistive Cables"
G. CSA C22.2 #124
H. UL Fire Resistance Directory

1.3 SUBMITTALS
A. Provide product data on the following:
   1. 600-volt conductor, splicing and terminating materials.
   2. MI cable
B. Provide cable high voltage factory test reports.

PART 2 - PRODUCTS

2.1 IDENTIFICATION
A. Provide new insulated conductors marked according to NEC Article 310.

2.2 600-VOLT INSULATED CONDUCTORS
A. Size. As shown on the drawings.
B. Construction.
   1. Conductor. Soft-drawn, annealed copper. Solid for #12 and #10 and Stranded for all other sizes.
   2. Insulation. Unless otherwise noted on the drawings, use THHN/THWN-2 for general wiring. Use XHHW/XHHW-2 for conductors installed below grade.

C. Use. For general wiring use No. 12 minimum. For field-installed control wiring use No. 14 or larger stranded conductors.

D. Listing. Single Conductor. UL 83.

2.3 TYPE MI – MINERAL INSULATED CABLE

A. Size as shown on drawings

B. Construction
   1. Conductor: Solid high conductivity copper
   2. Insulation: 600V, magnesium oxide
   3. Fire Rating: Complex cable system shall have a 2 hour fire rating as used and classified by Underwriters Laboratories, Inc.

C. Manufacturer: Pentair/Pyrotenax

PART 3 - EXECUTION

3.1 INSTALLATION

A. Protection. Unless otherwise indicated, mechanically protect conductors for systems by installing in raceways. Do not install the conductors until raceway system is complete and properly cleaned. Use Polywater J cable lubricant when pulling conductors. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors, or less than twelve times the outer diameter of the completed 15 kV cable. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Splices and Terminations. Use pressure-type lugs or connectors for terminations or splices of all stranded conductors. Use ring-tongue type terminators on all control wiring. Below grade terminations shall be waterproof.

C. Appearance. Neatly and securely bundle or cable all conductors in an enclosure using nylon straps with a locking hub or head on one end and a taper on the other.

3.2 600-VOLT INSULATED CONDUCTORS

A. Size. Install conductor sizes as indicated.
B. Home Runs. Provide branch circuit homeruns as indicated on plans. Homerun designations are indicated on Sheet E-001. Provide the number of homeruns as indicated on plans. A maximum of 6 phase conductors may be installed in one conduit. Include a separate neutral conductor with each phase conductor for all 120V and 277V circuits. Common neutrals are not permitted. Use home run circuit numbers as indicated for panelboard connections. For isolated ground circuits provide an additional ground conductor as indicated on the panel schedules. Provide No. 10 AWG conductor for the entire circuit length for single-phase, 20 ampere circuits for which the distance from panelboard to the last outlet is more than 100 feet for 120 volt circuits and 200 feet for 277 volt circuits.

C. Color Code. Use factory-colored insulated conductors for No. 10 and smaller conductors and color code larger insulated conductors with an approved field-applied tape. Use different colors for control wiring. Follow the color scheme below.

<table>
<thead>
<tr>
<th>Line</th>
<th>208/120</th>
<th>480/277</th>
</tr>
</thead>
<tbody>
<tr>
<td>A or L1</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B or L2</td>
<td>Red</td>
<td>Purple</td>
</tr>
<tr>
<td>C or L3</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Switch Leg</td>
<td>Pink</td>
<td>Pink</td>
</tr>
</tbody>
</table>

Where more than one conductor of the same phase or more than one neutral conductor occur at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. All wiring associated with isolated ground receptacles (line, neutral, ground) shall have a yellow tracer on each conductor.

D. Field Testing. Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using a Biddle Megger of not less than 1000 volts d-c. Insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have a minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Owner in accordance with Section 26 05 00. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

3.3 TYPE MI – MINERAL INSULATED CABLE

A. Size – Install conductor sizes as indicated.

B. Home runs: Install cable per manufacturer’s instructions

C. Color Code/label: Label each individual cable every 5’ with the following: 600V 2HR fire rated cable.
SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 WORK INCLUDED
A. This section specifies the furnishing and installing of grounding and bonding equipment for electrical systems.

1.2 REFERENCE STANDARDS
B. ANSI/TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
C. ANSI/UL 467 - Grounding and Bonding Equipment.
F. NFPA 70 - National Electrical Code (NEC).

1.3 RELATED WORK
A. Section 26 27 30, Isolated Power Systems.
B. Division 27, Communications.
C. Division 28, Electronic Safety and Security.

1.4 SUBMITTALS
A. Product Data. Submit product data sheets, including complete descriptive information on materials and installation methods.
B. Shop Drawings.
   1. Provide detailed plans prepared to 1/8-inch scale with 1/8-inch text which indicate the work to be performed. Details of component mounting and connections shall be included on separate detail drawings. Manufacturer's catalog numbers and generic identification shall be indicated for components shown on the Drawings.
2. Shop drawings shall include locations of conductors, roof penetrations, floor penetrations, etc., and their compatibility with provisions made during the construction. Once the contract has been established the Contractor shall make a review of provisions being made for the system installation and comment, in writing, with changes or compliance within two weeks of finalizing the contract. Contractor shall coordinate locations of conductors in walls and penetrations with the appropriate trades. Failure to coordinate these requirements shall not relieve this Contractor from properly completing this work. The Contractor shall employ the proper trades to provide the chases in walls and roof and floor penetrations required to install the conductors if not coordinated before the floors, walls and roof are installed.

C. Coordinated Submittal.
1. Submit product data and shop drawings for grounding system and lightning protection system at the same time and as one package. Indicate common components and interconnections between grounding and lightning protection systems. Refer to Section 26 41 00 for Lightning Protection system.
2. Coordinate submittal for grounding system with electrical service to building and with electrical service equipment.
3. Note to specifier: confirm this requirement with Division 27 communications designer/specifier.
4. Coordinate submittal for grounding system with telecommunications grounding system, as indicated on telecommunications Drawings. Refer to Division 27 telecommunications systems grounding system and grounding requirements.

D. Approvals: Secure formal approval of shop drawings and product data prior to ordering material. Secure approvals in sufficient time to allow installation of concealed system components without delaying the project.

E. Testing: Submit documentation for field testing of completed grounding system, as required under paragraph 3.7B of this Section.

F. Note to specifier: edit for Owner preferences on file format and media

G. As-Built Record Drawings. The Contractor shall maintain a master set of As Built record drawings that shows changes and deviations from the Drawings, in accordance with Division One requirements and Section 26 00 00. Deliver As-Built record drawings to Owner upon Owner acceptance of project. Where not specified otherwise in Division 1 or the General and Supplementary Conditions of the construction contract, deliver one set of As-Built record drawings plotted full-scale on mylar with permanent ink, prepared to 1/8-inch scale with 1/8-inch text. Also deliver one set of As-Built record drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).

PART 2 - PRODUCTS

2.1 GROUND RODS

A. Materials. Provide 3/4-inch by 10-foot long, copper-clad, steel grounding electrodes. Supply a rod to which the copper cladding is permanently and inseparably bonded to a high strength steel core.

B. Listing. UL 467.
2.2 CONNECTIONS

A. Materials. Unless otherwise noted, provide exothermic welded type grounding connections for bonds and connections made below grade, embedded in structure, or otherwise concealed. For above grade connections not embedded in structure or otherwise concealed, provide mechanical bolted-type connections utilizing high-conductive copper alloy or bronze lugs or clamps. Where required, provide plated connectors which will not cause electrolytic action between the conductor and the connector.

B. Listing. UL 467.

2.3 CONDUCTORS

A. Materials. Provide grounding conductors fabricated from annealed copper with conductivity ≥ 98 percent IACS conductivity.
   1. Use solid conductor for No. 12 and No. 10 AWG.
   2. Use stranded conductor for No. 8 AWG and larger.
   3. Use stranded conductor for applications subject to continuous vibration, such as engine generators and terminations at motors.
   4. Use stranded, tinned, annealed copper cable for #2 AWG or larger installed inside the building or structure.

B. Insulation. Where insulated grounding conductors are specified or required, provide green-colored 600-volt rated insulation, type XHHW, THWN, or RHW. Insulation type shall be compatible with associated power and lighting system conductors.

C. Location and Application.
   1. Inside building or structure. Provide insulated copper grounding conductors, except where bare copper grounding conductors are indicated on Drawings or specified in this or other Sections.
   2. Outside building or structure. Use bare copper grounding conductors, including below-grade building grounding ring (counterpoise).

D. Listing. UL 83.

2.4 GROUND BUS

A. Where a field-provided ground bus-bar is required or indicated, provide bus-bar drilled and tapped with double-lug terminations for the quantity of ground connections indicated on the Drawings plus 25% spare capacity, wall-mounted on insulated supports. Use round-edge copper bar with ≥ 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus-bar for not less than 25 percent of the aggregated cross-sectional area of the related feeders. A minimum cross-sectional size of 1/4 inch by 2 inches is required; where ground bus-bar of larger dimensions is indicated on plans or specifications provide the bus-bar with the larger dimensions. See E 2.4B for chemical ground rod measurements in test well.
PART 3 - EXECUTION

3.1 GENERAL

A. Install grounding system in accordance with the requirements of the National Electrical Code (NEC), Article 250, and other applicable codes and standards. Coordinate installation of grounding and lightning protection system components with structural and civil work and placement of building structural mat.

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Connection to ground busbars is permitted as an exception to the restriction against splices in grounding conductors. Grounding conductors shall be as short and straight as possible, and protected from mechanical damage.

C. Connect grounding electrode conductors to metal water pipe using suitable ground clamp, where metal water pipe is available and accessible and not protected by an insulating anti-corrosion covering. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter. The grounding electrode conductor shall not be spliced.

D. Install fusion welded (exothermic) grounding connectors where they are below grade, concealed, or inaccessible. Above grade at accessible locations, use copper or bronze lugs and clamps. Grounding and lightning protection system connections made in conjunction with placement of the building structural mat shall be exothermic ground connectors.

E. Strap grounding clamps shall not be used. Connections requiring bolting shall be made up with Monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.

F. Where grounding conductors are installed in raceway, provide Schedule 40 PVC conduit inside the footprint of the building, and Schedule 80 PVC conduit for exterior or other locations outside the footprint of the building. Where exposed inside the envelope of the building, install grounding conductors in metallic raceway unless specifically indicated on Drawings to omit raceway. Where grounding conductors are installed in metallic raceway, bond to each end of metallic raceway where grounding conductors enter or exit the metallic raceway system. Metallic raceway systems that would form electrically inductive chokes shall not be used.

G. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors.

3.2 SYSTEM DESCRIPTION

A. Ground the electrical service neutral at service entrance equipment. Provide a main bonding jumper between the neutral and ground bus of the 480-volt main switchgear. Provide a separate grounding electrode conductor in conduit with grounding bushings on both conduit ends from the switchgear to the master ground bus-bar (MGBB) at the main electrical room. Bond MGBB to cold water metallic service pipe in contact with at least 10 feet of earth, and connect to opposite points of the building grounding ring (i.e. counterpoise) system by two main grounding conductors.
B. Provide ground bus-bar, wall-mounted on insulated supports at 8'-0" AFF in electrical rooms, and radially connected to a master ground bus-bar in the main electrical room. See paragraph 3.5A, this Section.

C. Separately Derived Systems: Ground the neutral of each separately derived system in accordance with NEC-250.30 and paragraph 3.3G, this Section.

D. Provide communications system-grounding conductor at point of service entrance and connect to separate grounding electrode. Bond together the communications system grounding electrode and the electrical service-grounding electrode. Separate grounding systems without interconnecting bonds or jumpers are prohibited.

E. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.3 EQUIPMENT GROUND

A. Electrical Rooms: Provide a ground bus in electrical rooms, and at other locations indicated on Drawings.
   1. Mount busbar 8 feet above finished floor and a minimum of 1 inch from wall.
   2. Connect busbar by grounding conductor to the main ground busbar at the main electrical room. Size grounding conductor as shown on Drawings. Where size is not indicated, use grounding conductor with cross-sectional area equivalent to the ground busbar.
   3. Connect to the ground bus noncurrent-carrying metallic parts of electrical equipment and enclosures in the room.
   4. Bond grounding conductors to the bus as further indicated on Drawings.
   5. Provide #4/0 AWG copper conductor group loop around interior perimeter of electrical room at 8'-0" above finished floor level. Bond to each end of ground bus-bar by exothermic weld (i.e. cadweld). Make equipment grounding connection to copper loop by exothermic weld, where direct connection to ground bus-bar is not feasible.

B. Raceway Systems and Equipment Enclosures.
   1. Bond cabinets, cable trays, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, switchboards, panelboards, transformer enclosures, other electrical equipment and metallic enclosures. Bond equipment and enclosures to the continuous-grounded, metallic raceway system in addition to other specific grounding shown. Ground each outlet by the use of an approved grounding clip attached to the outlet box in such a position to be readily inspected upon removal of the cover plate, or by the use of an approved grounding yoke type receptacle.
   2. Provide bonding jumpers and grounding conductors throughout the raceway system to ensure electrical continuity of the grounding system and the raceway.
   3. Provide grounding-type insulated bushings for metal conduits 1-1/2 inches and larger terminating in equipment enclosures containing a ground bus. Connect the bushing to the ground bus in the equipment enclosure.
   4. Provide a green insulated equipment grounding conductor for each feeder and branch circuit. Terminate each end of grounding conductor on a grounding lug, bus, or bushing.
   5. Provide internal grounding conductor on liquid tight flexible metal conduit ("sealtite") with ground bushings.
6. Provide a flexible bonding jumper for isolated metallic piping and ductwork and around expansion fittings and joints.

C. Size. Where grounding and bonding conductors are not sized on Drawings, size the grounding conductors in accordance with NEC Table 250.122. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250.122.

D. Taps, Splices and Connections: Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends.

3.4 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Testing: Test the completed grounding system by fall-of-potential method. Measure ground resistance from system grounding electrode main conductors to convenient ground reference point using suitable ground testing equipment.
   1. Prepare test procedures and test forms to be used for field testing of completed grounding system. Procedures and forms shall include documentation of test equipment proposed for use in field testing of completed grounding system.
   2. Resistance shall not exceed 1 ohm.
   3. Testing points shall include measurement of ground resistance from system neutral at electrical service entrance to convenient ground reference point using suitable ground testing equipment.
   4. Where measured resistance to ground exceeds 1 ohm, add additional ground rods to grounding system to achieve system resistance to ground of 1 ohm or less, and document measured resistance to ground after ground rods are added. Repeat as required to achieve resistance to ground of 1 ohm or less, at no additional cost to Owner.

C. Refer to Sections 26 05 19 and 26 27 30 for testing of isolated power systems per NFPA 99.

D. Documentation: Submit report of field testing of completed grounding system to Architect/Engineer and to Owner’s Representative.

3.5 CONFLICTS

A. In the event a conflict exists between this specification and the referenced standards, the requirements of this specification shall be regarded as secondary and the necessary variances made in order to obtain a UL Master label for the lightning protection system.

END OF SECTION
SECTION 26 05 33

RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of electrical raceway systems.

1.2 REFERENCE STANDARDS

A. ANSI/ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated.
B. ANSI/ANSI C80.3 - Electrical Metallic Tubing - Zinc-Coated.
C. ANSI/UL 1 - Flexible Metal Conduit.
D. ANSI/UL 5 - Surface Metal Raceways and Fittings.
E. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
F. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
G. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit.
H. ANSI/UL 797 - Electrical Metallic Tubing.
I. ANSI/UL 870 - Wireways, Auxiliary Gutters and Associated Fittings.
J. NEMA VE 1 - Metallic Cable Tray Systems.
K. NEMA TC-6 and 8 – EB Underground Conduit
L. UL 6 - Rigid Metal Conduit.

1.3 SUBMITTALS

A. Surface metal raceways and fittings.
B. Provide product data on cable tray and fittings.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. Rigid Metal Conduit.
   2. Fittings. Threaded steel or malleable iron, either cadmium plated or hot-dipped galvanized.
B. Electrical Metallic Tubing (EMT).
   2. Fittings. Steel compression type or steel set screw fittings, either cadmium plated or hot-dipped galvanized. Connectors shall have insulated throat bushings.

C. Rigid Nonmetallic Conduit.
   2. Fittings. Solvent weld socket type.

D. Flexible Metal Conduit.
   2. Fittings. One-screw and two-screw for 1-1/2 inches and larger, double-clamp steel or malleable iron, either cadmium plated or hot-dipped galvanized.

E. Liquid-tight Flexible Steel Conduit.
   1. Conduit. Spiral-wound, square-locked, hot-dipped galvanized steel strip plus a bonded outer jacket of PVC.
   2. Fittings. Compression type, malleable iron, with insulated throat, either cadmium plated or hot-dipped galvanized.

F. Elbows.
   1. Provide large radius elbows.

2.2 WIREWAYS

A. Material. Not less than 16-gage sheet steel.

B. Dimensions. Cross section dimensions not less than 4 inches by 4 inches.

C. Finish. Not less than two coats of enamel over a rust-inhibiting prime coat.

D. Type.
   1. Indoors. NEMA 1.
   2. Outdoors. NEMA 4X.

2.3 SURFACE RACEWAYS AND FITTINGS

A. Provide two compartment aluminum raceway for power and data. See plans for specifications.

2.4 CABLE TRAY AND FITTINGS

A. Cable tray shall be 18" wide by 6" deep, B-Line series WB618 or equal.

B. Tray: NEMA VE 1/CSA E22.2 No. 126.1.

C. Material and Finish of Tray, Fittings, and Accessories: Electroplated yellow zinc dichromate per ASTM B633 SC2.

D. Inside radii of fittings: as indicated on Telecom Drawings

E. Accessories and Fittings: Manufacturer's standard clamps, tees, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
F. Warning signs for cable trays:
   1. 1/2-inch high black letters on yellow plastic with the following wording:
       "WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!"

PART 3 - EXECUTION

3.1 CONDUIT AND FITTINGS

A. Minimum Trade Size. 3/4 inch, except that 1/2-inch flexible metal conduit may be used in lengths not exceeding 72 inches for tap conductors supplying lighting fixtures.

B. Types According to Use.
   1. Use hot dipped galvanized rigid steel conduit (RGS) outside above ground where exposed to weather.
   2. Use EMT in interior walls or ceiling spaces and where exposed in open work areas, mechanical rooms or electrical rooms. Conduit that enters or leaves the top of panelboards or enclosures may be EMT, provided such panelboards and enclosures are located in mechanical or electrical rooms.
   3. Conduits may not be embedded in slabs without approval of the owner and the structural engineer.
   4. Use rigid nonmetallic conduit (Type EB) encased in concrete with minimum 3-inch-thick walls, where installed below grade. Concrete encasement may be omitted when conduit is used for site lighting circuits. In these cases use Schedule 40 PVC. All horizontal to vertical transitions shall be made using RGS elbows RGS conduit stub-ups. Seal all conduits weather tight.
   5. Connect all indoor electrical equipment subject to vibration or movement with flexible metal conduit 24 inches minimum length. Where the equipment is located in a duct or plenum used for environmental air, the length of conduit shall not exceed 4 feet and the conduit shall be flexible metal conduit. Where the equipment is located outdoors or exposed to water, liquid-tight flexible metal conduit shall be used.
   6. Transitions.
      a. Continue the heavier, more protective type conduit application not less than 4 inches into the area where lighter, less protective type conduit is permitted.
      b. For below-grade to above-grade outdoor locations, extend concrete encasement around conduit 4 inches above finished grade and slope top away from conduit with a 6-inch-per-foot slope.
      c. For below-grade to above-grade locations using PVC to metal conduit, make the transition from PVC to metal conduit before turning up with RGS elbow.

C. Preparation. Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins.
D. Installation Requirements.

1. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For EMT terminations, provide insulated throat bushings and on rigid metallic conduits, provide nonmetallic insulating bushings for conductor protection. Where feeder conduits, 1-1/2 inches and larger, terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.

2. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.

3. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.

E. Installation Methods.

1. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.

2. Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90 percent based zinc paint. When dry, draw up tight.

3. Make bends with minimum 24” radius. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of four 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

4. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.

5. Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits. Branch circuit raceways which are 1 inch or smaller may be attached to wall studs by use of manufactured clips.

6. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading “Pulling Line - Telephone,” etc.

7. Suitably cap conduit during construction to avoid water, dirt and trash entrance.

8. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.

9. Use expansion fittings in conduit that terminates at sensitive equipment.

10. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.

11. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be firestopped to maintain the fire resistance rating using approved methods.

12. DELETE THIS PARAGRAPH IF THERE IS NO BSL-3 IN BUILDING
13. For biosafety level 3 (BL-3) vivarium facilities: All device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling or floor surface shall be sealed. All wiring shall be provided in threaded rigid galvanized steel (RGS) or intermediate metal conduits (IMC)(only when recessed). All device boxes shall be cast type. 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 silicone caulk shall be provided. Non-recessed conduits are then required to be on minimum ¾” standoffs, or if also surface mounted, both sides of the conduit shall be sealed to adjacent surfaces with silicone caulk. This provides for a gas tight electrical installation allowing decontamination of the BL-3 space, and prevents vermin harborage in and transmission through the electrical distribution systems.

14. DELETE THIS PARAGRAPH IF THERE IS NO BSL-2 IN BUILDING

15. For biosafety level 2 (BL-2) vivarium facilities: All device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling or floor surface shall be sealed. All wiring shall be provided in either threaded RGS, IMC (when recessed), or electrical metallic tubing (only 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 silicone caulk shall be provided. Non-recessed 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 distribution systems.

3.2 WIREWAYS

A. Install wireways, where shown, according to NEC Article 376. Field apply a 90 percent zinc paint coating over cuts or scratches before any other finish is applied.

3.3 SURFACE RACEWAYS

A. Install surface raceways, where shown, according to NEC Article 300. Securely ground raceway and fittings. Provide bushings at raceway entrances. Raceways shall be two compartment, top for receptacles and bottom for data. Provide power conduit and wiring as shown on plans. Provide 1-1 ¼” conduit from data compartment to cable tray. Conduit shall terminate in a flush mounted box at surface raceway location. Provide a 2” nipple between the box and the back of the surface raceway.

3.4 CABLE TRAY

A. Install in conformance with NEC and NEMA requirements and in accordance with manufacturer's instructions. Arrange cable tray to maintain headroom and present neat appearance. Cables shall be arranged in cable trays in a neat, workmanlike manner.

B. All cable tray cuts/modifications shall be done with manufacturer approved cutters.
C. Support cable tray a minimum of every 5’ on center with manufacturer provided trapeze support kit. Kit shall be a B-Line Model WB5518 for use with 3/8” all thread rod. Provide all accessories necessary for a complete installation. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 5 feet maximum. Trays shall be level.

D. Contactor shall utilize manufacturer’s standard components. Where standard components are not available, modifications shall be per manufacturers instructions/specifications.

E. Provide a continuous solid barrier that is electrically continuous installed in all sections of the cable tray. The purpose of the barrier is to separate AV cables from telecom cables. Place the barrier such that ¼ of the tray will be for AC cabling and ¾ of the tray will be for telecom cables.

F. Where it is necessary to make field changes in the tray system, all changes shall be made per manufacturers recommendations.

G. Maintain twelve-inch clearance between cable tray and surfaces with temperatures exceeding 104 degrees F, such as flues, steam pipes, and heating appliances. Maintain at least 4-inch clearance between cable tray and piping, ductwork or other interference. Any deviation from this must be approved by the Owner. It shall be the Contractor’s responsibility to protect existing cable tray in the area of construction against damage throughout the construction period. Any damaged cable tray shall be replaced by the Contractor at no additional cost prior to final acceptance by the Owner.

H. All communication cable trays shall have a continuous, No. 6, green insulated copper grounding conductor run inside the tray. Connect to tray at each fitting or tray section. Connect the tray at each end to the ground bar in the telecom room with #4 AWG. All bonds shall be via exothermic weld. The direction of the welded bond shall be oriented in the correct direction along bonding backbone.

I. Maintain electrical continuity between sections of cable tray using manufacturer provided splice plates and bond cable trays at the both ends to building ground plates to provide a continuous grounding path. Install copper braided bonding jumpers around expansion joints and hinged adjustable splice plates where electrical discontinuity occurs. Install cable trays, where shown, according to NEC Article 392. Install cable trays in accordance with manufacturer’s recommendations.

END OF SECTION
SECTION 26 05 37
BOXES

PART 1 - GENERAL

1.1 SUMMARY
A. This Section specifies the furnishing and installation of outlet boxes, floor boxes, junction boxes and pull boxes.

1.2 REFERENCE STANDARDS
A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.
B. ANSI/UL 514A - Metallic Outlet Boxes.
C. ANSI/UL 514B - Fittings for Conduit and Outlet Boxes.

1.3 SUBMITTALS
A. Provide product data.

PART 2 - PRODUCTS

2.1 JUNCTION, PULL AND SPLICE BOXES
A. Construction. Provide galvanized steel boxes conforming to NEC Article 314.
B. Interior Spaces. Provide NEMA 1 type boxes at least 4 inches deep.
C. Exterior Spaces. Provide NEMA 4X type boxes at least 4 inches deep.
D. Embedded. Provide NEMA 4 cast iron type with flush flanged cover when cast in concrete.
E. Listing. UL 514.

PART 3 - EXECUTION

3.1 JUNCTION AND PULL BOXES
A. Installation. Install boxes as required to facilitate cable installation in raceway systems. Provide a junction box for terminating of flexible metal conduit to light fixtures. In general provide boxes in conduit runs of more than 100 feet.
B. Covers. Provide boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above inaccessible ceilings. Select a practical size for each box and cover.

END OF SECTION
SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED
A. Nameplates and tape labels.
B. Wire and cable markers.
C. Conduit color coding and labeling.

1.2 REFERENCES
A. NFPA 70 – National Electrical Code (NEC).

1.3 SUBMITTALS
A. Provide submittals in accordance with and in additional to Section 26 00 00, Electrical General Provisions, and Division 01, for submittal requirements.
   1. Furnish nameplate identification schedules to Owner’s Representative for review and acceptance, listing equipment type and nameplate data with letter sizes and nameplate material.
   2. Nameplate Schedules. Prior to fabrication of nameplates, furnish to Owner for review and acceptance a schedule of nameplates for electrical equipment. For each equipment and circuit identified, provide 4-line nameplate as follows:
      a. Line 1: Device designation, switchgear or MCC cubicle, switchboard circuit, etc. as indicated on plans, schematics, or schedule Drawings.
      b. Line 2: Leave blank for Owner’s use.
      c. Line 3: Source or voltage characteristics, as applicable.
      d. Line 4: Load served.
   3. Refer to Parts 2 and 3 of this Section for nameplate requirements.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Equipment Nameplates:
   1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.
   2. For emergency equipment, provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.
   3. Nameplate minimum size shall be 1 inch high by 3 inches long with engraved white letters. Generally, the number and name shall be at least 1/4 inch high and other data at least 1/8 inch high.

B. Underground Warning Tape:
   1. Manufactured polyethylene material and unaffected by acids and alkalines.
   2. 3.5 mils thick and 6 inches wide.
   3. Tensile strength of 1,750 psi lengthwise.
4. Printing on tape shall include an identification note “BURIED ELECTRIC LINE”, and a caution note “CAUTION”. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.

5. Detector Strip. Metallic tape or similar detector strip, integral to warning tape.

C. Conductor Color Tape and Heat Shrink:
   1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
   2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of conductor or cables are not acceptable.

D. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2 inch lettering.

E. Tape Labels: Provide device labels of plastic adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.
   1. Normal power. Black letters on clear background. Provide white letters on black background where specifically indicated on Drawings or specified in other Sections.
   2. Emergency/standby power. Red letters on clear background. Provide white letters on red background where specifically indicated on Drawings or specified in other Sections.
   3. UPS power. Orange letters on clear background. Provide white letters on orange background where specifically indicated on Drawings or specified in other Sections.
   4. Provide device label with black letters, one half inch wide tape with one quarter inch high letters, minimum.
   5. Manufacturer. Brother type “P-Touch”, or accepted substitution.

F. J-Box and Cover plate Voltage Labels: Black stenciled letters 1/4 inch high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in individually wrapped factory-fabricated fiberboard-type containers.

B. Store materials in a clean and dry space, elevated above grade, and protected from weather and sunlight.

C. Handle materials carefully to avoid damage, breaking, denting and storing. Damaged materials shall be rejected and shall not be installed.

3.2 INSTALLATION

A. Degrease and clean surfaces to receive nameplates or tape labels.

B. Install nameplates parallel to equipment lines.
C. Secure plastic nameplates to equipment fronts using stainless steel self-tapping screws or rivets. Use of adhesives shall be per Owner’s approval. Stick-on or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

D. Designations: Externally mark equipment, feeders, branch circuits and similar items with nameplates with the same designations as indicated on the Drawings.

3.3 WIRE AND CONDUCTOR IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, ground busbars, and at load connection.
   1. Identify with branch circuit or feeder number for power and lighting circuits.
   2. Label control conductor with number as indicated on schematic and interconnection diagrams or equipment manufacturer’s shop drawings for control wiring.
   3. Label grounding conductors at ground busbars, electrical equipment, and test wells with metal tags indicating the cable purpose and point of termination at opposite end of cable. Securely fasten metal tags along the length of the grounding cable or conductor. Place metal tags to avoid creating short circuits, inadvertent grounding paths, or other contact with grounded or energized terminals, conductors, or components.

B. Existing Facilities. Where the Contractor encounters conductor identification in existing electrical distribution systems different from the colors scheduled in this Section, notify the Owner’s Representative in writing and propose a resolution, in accordance with the requirements of Part 1 of Section 26 00 00, Electrical General Provisions.

C. Conductors for power and lighting circuits shall be identified per the following schedule.

<table>
<thead>
<tr>
<th>Conductor</th>
<th>480/277V</th>
<th>208/120V</th>
<th>Medium Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Brown</td>
<td>Black</td>
<td>One White Band</td>
</tr>
<tr>
<td>Phase B</td>
<td>Purple</td>
<td>Red</td>
<td>Two White Bands</td>
</tr>
<tr>
<td>Phase C</td>
<td>Yellow</td>
<td>Blue</td>
<td>Three White Bands</td>
</tr>
<tr>
<td>Neutral</td>
<td>Gray</td>
<td>White</td>
<td>N/A</td>
</tr>
<tr>
<td>Grounding</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Isolated Ground (IG)</td>
<td>N/A</td>
<td>Green w/Yellow Tracing Stripe</td>
<td>N/A</td>
</tr>
</tbody>
</table>

D. Where more than one conductor of the same phase or more than one neutral or ground conductor occurs at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. The neutral tracer color shall match the phase conductor color with which it is associated.

E. Switch leg conductors. Pink.
   1. The color of switch leg conductors shall be pink, marked with tape matching the color of the associated branch circuit phase conductors.
F. Low voltage wiring systems. Conductors for low voltage circuits shall be identified as follows.
1. Fire Alarm. Red
2. Security. Blue and Yellow. Coordinate wiring color with Division 27 and telecommunications supplier
3. Clock. Green and White
4. Telephone. White. Coordinate wiring color with Division 27 and telecommunications supplier
5. Data. Bright Blue. Coordinate wiring color with Division 27 and telecommunications supplier.
6. HVAC Controls. Dark Blue. Coordinate wiring color with Division 23 and controls supplier.

3.4 NAMEPLATES

A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.
1. Externally mark electrical equipment with nameplates identifying each and the equipment served.
2. Supply blank nameplates for spare units and spaces.

B. Nameplate Fasteners. Fasten nameplates to the front of equipment by means of stainless steel self-taping screws. Stick-on or adhesives are not allowed unless the NEMA enclosure rating is compromised, then use only epoxy adhesive to attach nameplates.

C. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4 inch: identify source to device and the load it serves, including location.

D. Identification tags on items in finished areas, such as special switches, etc., shall be securely attached on, or in the immediate vicinity, of the item. Supply blank nameplates for spare units and spaces.

3.5 ENCLOSURE COLOR CODING

A. The following systems shall have each junction and pull box cover completely painted per the following:

<table>
<thead>
<tr>
<th>System</th>
<th>Color of Box Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet Backbone</td>
<td>Blue</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>Brown</td>
</tr>
<tr>
<td>FCMS</td>
<td>Green</td>
</tr>
<tr>
<td>Emergency Power</td>
<td>Red, with black “E” text</td>
</tr>
<tr>
<td>Security**</td>
<td>White</td>
</tr>
<tr>
<td>Fire Alarm</td>
<td>Red, with black “FA” text</td>
</tr>
<tr>
<td>Clock</td>
<td>Fluorescent Violet</td>
</tr>
</tbody>
</table>
**Security shall include, but not be limited to, the following systems:  
- Card Access  
- Duress Alarms  
- Perimeter Door Alarms

B. CCTV

### 3.6 EQUIPMENT AND DEVICE MARKING

A. Pull, Junction and Outlet Boxes.  
1. With 1/2-inch high permanent lettering, identify conduits connected to pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Identify complete circuit numbers on box cover and on the conduit.  
2. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags which indicate circuit designation. Identify both phase and associated neutral conductors.  
3. Boxes and covers containing emergency power or emergency lighting circuits shall be painted red. Factory finish is acceptable in lieu of painting in the field. No other raceway, conduit, boxes, or enclosures shall be painted red.
AHU-20-1 CHW PUMP REPLACEMENT
Houston, Texas
ISSUE FOR CONSTRUCTION

SHAH SMITH & ASSOCIATES, INC.
2825 Wilcrest Drive, Suite 350
Houston, Texas 77042
P: 713-780-7563
F: 713-780-9209
Tx. Registration #F-2113

DRAWING LIST - MECHANICAL
CS COVER SHEET
M-105 MECHANICAL LEGENDS, GENERAL NOTES AND SCHEDULES
M-150 LEVEL 20 EAST MECHANICAL ROOM LAYOUT PLAN

DRAWING LIST - ELECTRICAL
E-101 ELECTRICAL LEGENDS SYMBOLS AND ABBREVIATIONS
E-156 EAST MECHANICAL ROOM LEVEL 20
SYMBOL
SUPPLY/OUTSIDE AIR DUCT
RETURN AIR DUCT
CONDUIT/CONDUIT THROTTLE VALVE
CROSSFLOW DAMPER
VENTILATION AIR DUCT
DISTANCE BETWEEN BOXES
TEMPORARY AIR DUCT
GAGE COCK
RETURN AIR DUCT
EXHAUST/RELIEF AIR DUCT
FIRE/FIRE SMOKE DAMPER
ELEVATIONS FROM THE FINISHED FLOOR DIRECTLY BELOW TO THE NEW WORK
VOLUME DAMPER
SUPPLY AIR DIRECTION
EXHAUST/RETURN DIRECTION
1 WAY CONTROL VALVE
2 WAY CONTROL VALVE
DUCT SIZE SHOWN ARE NET FREE AIR PASSAGE DIMENSIONS.
COORDINATE INSTALLATION OF EQUIPMENT AND PIPING WITH ELECTRICAL CONTRACTOR TO INSURE NEC CLEARANCE IN FRONT OF ALL ELECTRICAL PANELS.
AIRCIRCULATING VOLUME DAMPER
EASY REMOVAL OF EQUIPMENT, COILS, FANS, MOTORS, FILTERS, VOLUME DAMPER
GALLONS PER MINUTE
VOLUME DAMPER
APM (GPM)
CPS (HEAD (FT)
TOTAL
MARK LOCATION SERVICE
MARK LOCATION SERVICE
NOTE: PROVIDE CURRENT SWITCH PROOF OF RUN ACROSS THE PUMP.
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GENERAL NOTES

AND EQUIPMENT REFER TO THE SPECIFICATIONS FOR ADDITIONAL INFORMATION.

LEGEND

EXISTING TO REMAIN
TO BE DEMOLISHED

A. INSULATE ALL NEW CHILLED WATER PIPING AND EQUIPMENT. REFER TO THE SPECIFICATIONS FOR ADDITIONAL INFORMATION.

LEVEL 20 - ENLARGED EAST MECHANICAL ROOM - DEMOLITION PLAN

1. DEMOLISH EXISTING PUMP AT THE LOCATION SHOWN. REMOVE PIPE SECTIONS AS NECESSARY FOR NEW PUMP INSTALLATION. REFER TO 2/M-100-20E FOR ADDITIONAL INFORMATION.

2. PROVIDE NEW INLINE CHILLED WATER PUMP AT THE LOCATION SHOWN. REFER TO VERTICAL INLINE PUMP DETAIL ON M-001 FOR ADDITIONAL INFORMATION. REUSE EXISTING HANGERS AND SUPPORTS AS POSSIBLE.

3. REPAIR EXISTING CHILLED WATER PIPING AND EQUIPMENT INSULATION. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.

4. THE NEW PUMP CONTROL POINTS SHALL BE CONNECTED TO BAS EXISTING EQUIPMENT CONTROLLER LOCATED WITHIN THE MECHANICAL ROOM.

KEYED NOTES - M-100-20E

The University of Texas Health Science Center at Houston
AHU-20-1 CHW PUMP REPLACEMENT
LEVEL 20 EAST MECHANICAL ROOM ENLARGED PLAN

No. Description Date

Issue for Construction 08/23/2019
08/26/2019
08/26/2019