SPECIFICATIONS - DIVISION 1 – GENERAL REQUIREMENTS

DIVISION 01 – GENERAL REQUIREMENTS

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SECTION 01010 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. **BASE BID:** Work for this project will consist of replacing the two-wall mounted high efficiency Weil McLain Ultra units with two (2) high efficiency modular boilers, and in-line circulation pumps.

The project will require the replacement of existing gas piping, installation of new control devices and modification to the building DDC control system as required by the district standards.

Work Includes all labor, materials, equipment, and services for the removal of the existing equipment; the installation of new equipment complete, including controls, piping, and electrical service; testing, adjusting, and balancing. Buildings shall be restored to better than existing condition (finishes.)

Work associated with the project includes the following: All demolition work shown in the affected areas. Proper waste disposal and recycling efforts. Extending the building's electrical services to support the new work.

B. **All work shall be completed according to the construction schedule. No work will be allowed within the buildings after the published completion date.**

C. ALTERNATE(S) are listed in Section 01030.

D. Project location: FWP Miles City
352 I-94 BL
Miles City, MT 59301

E. Contract Documents dated September 22, 2022 were prepared for the project by Con'eer Engineering, 1629 Avenue D, Suite 7C, Billings, MT 59102.

F. The work will be contracted under a single prime contract and will include General, Electrical and Mechanical work.

1.3 CONTRACTOR USE OF PREMISES

A. General: During the construction period, the Contractor shall have full use of the construction site for construction operations; however, the Owner will retain occupancy of various portions of the project. The Contractor's use of the site is limited only by the Owner's right to perform work or to retain other contractors on portions of the project.

B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the work is indicated.
   1. Owner Occupancy: Allow for Owner occupancy and use by the public of all surrounding facilities.
   2. Driveways and entrances: Keep driveways and entrances serving the area clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.

END OF SECTION 01010

SECTION 01027 - APPLICATIONS FOR PAYMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment. i.e. Form 101 – Periodic Estimate of Partial Payment.
   1. Coordinate the Schedule of Values and Applications for Payment with the Contractor's Construction Schedule, Submittal Schedule, and List of Subcontracts.

B. The following sections contain requirements that relate to this Section:
   1. Schedules: The Contractor's Construction Schedule and Submittal Schedule are specified in Division 1 Section 01300 – SUBMITTALS.

1.3 SCHEDULE OF VALUES

A. Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.
   1. Correlate line items in the Schedule of Values with other required administrative schedules and forms including:
      a. Contractor's Construction Schedule.
      b. Application for Payment forms, including Continuation Sheets.
      c. List of subcontractors.
      d. List of products.
      e. List of principal supplier and fabricators.
      f. Schedule of submittals.
   2. Submit the Schedule of Values to the Engineer at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.

B. Format and content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one-line item for each of the Specification Divisions 2 through 14, and each sub-section of Divisions 15 and 16. The Schedule of Values shall also indicate each project phase.
   1. Identification: Include the following project identification on the Schedule of Values:
      a. Project name and location.
      b. Name of the Engineer.
      c. Project number.
      d. Contractor's name and address.
      e. Date of submittal.
   2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
      a. Related Specification Section or Division.
      b. Description of work.
      c. Approved Change Orders (numbers) that affect value.
      d. Dollar value.
   3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project

Manual table of contents. Break principal subcontract amounts down into several line items.

4. For the Schedule of Values, round amounts to the nearest whole dollar; the total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.
6. Provide separate line items on the Schedule of Values for initial cost of material, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Unit-Cost allowances: Show the line-item value of unit-cost allowances as a product of the unit cost, multiplied by the measured quantity. Estimate quantities from the best indication in the Contract Documents.
8. Margins of Cost: show line items for indirect costs, and margins on actual costs only when such items are listed individually in Applications for Payments. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.
   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place are to be shown as separate line items in the Schedule of Values.
9. Schedule updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders result in a change to the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Engineer and paid for by the Owner.
   1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
   2. All Applications for Payment shall be received by the Engineer by the 20th (twentieth) of the month.
   3. All Applications for Payment shall be accompanied by an updated project schedule.
   4. Lien Releases are required with all applications for Payment after the initial Application for Payment.

B. Payment Application times: Each progress-payment date is indicated in the Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Forms: Use Form 101 Periodic Estimate for Partial Payment as the form for Applications for Payment. Contractor is directed to include the Con'eer Project Number on all of the Pay Applications.

D. Application preparation: Complete every entry on the form. Include execution by a person authorized to sign legal documents on behalf of the Contractor. The incomplete applications will be returned without action.
   1. Entries shall match data on the Schedule of Values and the Contractor's Construction Schedule. Use updated schedules if revisions were made.
   2. Include amounts of Change Orders fully approved and issued prior to the last day of the construction period covered by the application. Do not include potential Change Order amounts that are not approved and issued yet.

E. Transmittal: **Submit two (2) signed original copies of each Application for Payment to the Engineer.** One copy shall be complete, including waivers of lien and similar attachments, when required.

1. **Electronic Option:** At the engineer's discretion, the Engineer may accept electronic submission of the Application for Payment if it is properly executed and notarized and complete with Lien Releases and similar scanned attachments when required. The email subject line shall identify the project, the project number and the Pay Application number in sequence. The sender should request a "read receipt" to ensure that the message is received by the Engineer's office. Verify the email address of the person to receive the Pay Application at the Engineer's office. One copy of each page should be included, not the two copies required for hard-copy Applications for Payment.
2. Submit original of forms that have an embossed corporate seal.

F. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:
1. List of subcontractors.
2. List of principal suppliers and fabricators.
3. Schedule of Values.
4. Contractor's Construction Schedule (Updated Monthly.)
5. List of Contractor's staff assignments.
6. Copies of building permits.
7. Copes of authorizations and licenses from governing authorities for performance of the Work.
8. Initial progress report.
9. Report of preconstruction meeting.
10. Certificates of insurance and insurance policies.
11. Performance and payment bonds.
12. Data needed to acquire the Owner's insurance.

G. Application for Payment at Substantial Completion (Phase and Project): Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.
1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
2. Administrative actions and submittals that shall precede or coincide with this application include:
    a. Occupancy permits and similar approvals.
    b. Warranties (guarantees) and maintenance agreements.
    c. Test/adjust/balance records.
    d. Maintenance instructions.
    e. Startup performance reports.
    f. Changeover information related to Owner's occupancy, use, operation and maintenance.
    g. Final cleaning.
    h. Application for reduction of retainage and Consent of Surety to Final Payment.
    i. Advice on shifting insurance coverages.
    j. List of incomplete Work recognized as exceptions to Certificate of Substantial Completion.

H. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment including the following:
1. Completion of project closeout requirements.
2. Completion of items specified for completion after Substantial Completion.
3. Ensure that unsettled claims will be settled.
4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
5. Transmittal of required project construction records to the Owner.
6. Proof that taxes, fees and similar obligations were paid.
7. Removal of surplus materials, rubbish and similar elements.

I. Waivers of Mechanics Lien: submit final Applications for Payment with or preceded by final unconditional Lien Releases **from every entity involved with performance of the Work covered by the Payment Application who is lawfully entitled to a lien, including suppliers and subcontractors. Submit Lien Releases on forms and executed in a manner acceptable to the Owner, including the Project Name and Project Number corresponding to the Engineer's Project Name and Number.**

J. Submit "Contractor's Affidavit of Completion, Payment of Debts and Claims, and Release of Liens" form, fully executed and notarized.

PART 2 – PRODUCTS – Not applicable.

PART 3 –EXECUTION - Not applicable.

END OF SECTION 01027

SECTION 01030 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes administrative and procedural requirements governing Alternates.

1.3 DEFINITIONS

A. Definition: An Alternate is an amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. The cost or credit for each alternate is the net addition to, or deduction from, the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum, Materials, labor, bond, taxes, insurance, incidentals, etc. shall be included in the price.

1.4 PROCEDURES

A. Coordination: Modify or adjust affected Work as necessary to integrate that Work completely and fully into the project.
   1. Include as part of each Alternate any miscellaneous devices, accessory objects, and similar items incidental to or required for a complete functioning installation whether mentioned as part of the Alternate.

B. Notification: Immediately following the award of the contract, notify each party involved, inwriting, of the status of each Alternate. Indicate whether Alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to Alternates.

C. Execute accepted Alternates under the same conditions as the other Work of this Contract.

D. Schedule: A “Schedule of Alternates” is included at the end of this Section. Specification sections referenced in the schedule contain requirements for materials necessary to achieve the Work described under each Alternate.

PART 2 - PRODUCTS – Not Applicable

PART 3 - EXECUTIONSCHEDULE OF ALTERNATES – No Alternates planned at this time.

END OF SECTION 01030

SECTION 01035 - MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.

B. The following Sections contain requirements that relate to this Section:
   1. Section 01027 Applications for Payment
   2. Section 01035.1.5 Allowances
   3. Section 01300 Submittals for requirements for the Contractor’s Construction Schedule
   4. Section 01300 Product Substitutions for administrative procedures for handling requests for substitutions made after award of the Contract.

1.3 MINOR CHANGES IN THE WORK

A. The Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract sum or Contract Time, on Engineer’s standard form.

1.4 CHANGE ORDER PROPOSAL REQUESTS

A. Owner-initiated Proposal Requests: The Engineer will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Proposal requests issued by the Engineer are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
   2. Within twenty (20) days of receipt of a proposal request, submit an estimate of cost necessary to execute the change to the Engineer for the Owner’s review.
      a. Include list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
      b. Include applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.

B. Contractor-initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Engineer.
   1. Include a statement outlining the reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract sum and Contract Time.
   2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
   3. Indicate applicable taxes, delivery charges, equipment rental and amounts of trade discounts.

4. Comply with requirements in Section “Product Substitutions” of the proposed change requires substitution of one product or system for a product or system specified.

1.5 CONSTRUCTION CHANGE DIRECTIVE

A. When the Owner and the Contractor disagree on the terms of a Proposal Request, the Engineer may issue a Construction Change Directive Form 109. The Construction Change Directive instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. The Construction Change Directive contains a complete description of the change in the Work. It also designates the method to be followed to determine change in the Contract Sum or Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
   1. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

1.6 CHANGE ORDER PROCEDURES

A. Upon the Owner’s approval of a Proposal Requests, the Engineer will issue a Change Order for signatures of the Owner and the contractor on Form 13.

PART 2 - PRODUCTS – Not applicable

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

3.3 Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

END OF SECTION 01035

SECTION 01040 - COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and supervisory requirements for coordinating construction operations including, but not necessarily limited to, the following:
   1. General project coordination procedures.
   2. Conservation.
   3. Coordination Drawings.
   4. Administrative and supervisory personnel.
   5. Cleaning and protection.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 1 SECTION 01300 – SUBMITTALS for preparing and submitting the Contractor's Construction Schedule.
   2. Division 1 SECTION 01600 – MATERIALS AND EQUIPMENT for coordinating general installation.
   3. Division 1 SECTION 01700 – CONTRACT CLOSEOUT for coordinating contract closeout.

1.3 COORDINATION

A. Coordinate construction operations included in various sections of these specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in the sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
   3. Make provisions to accommodate items scheduled for later installation.

B. Where necessary, prepare memoranda for distribution to each part involved, outlining special procedures required for coordination. Include such items as required notices, reports and attendance at meetings.
   1. Prepare similar memoranda for the Owner and for separate contractors where coordination of their work is required.

C. Administrative procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to the following:
   1. Preparation of schedules.
   2. Delivery and processing of submittals.
   3. Progress meetings minutes.
   4. Project close out activities.

D. Conservation: Coordinate construction operations to assure that operations are carried out with consideration given to conservation of energy, water, and materials.
   1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare coordination drawings where careful coordination is needed for installation of products and materials fabricated by separate entities. Prepare coordination drawing where limited space availability necessitates maximum utilization of space for efficient installation of different components.
   1. Show the relationship of components shown on separate Shop Drawings.
   2. Indicate required installation sequences.
   3. Comply with requirements contained in Section “Submittals.”

PART 2 - PRODUCTS – Not applicable.

PART 3 - EXECUTION

3.1 GENERAL COORDINATION PROVISIONS

A. Inspection of conditions: Require the installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in and acceptable manner.

B. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

3.2 CLEANING AND PROTECTION

A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration at Substantial Completion.

B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

C. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:
   1. Excessive static or dynamic loading.
   2. Excessive internal or external pressures.
   3. Excessively high or low temperatures.
   4. Thermal shock.
   5. Excessively high or low humidity.
   6. Air contamination or pollution.
   7. Water or ice.
   8. Solvents.
   9. Chemicals.
   10. Light.
   11. Radiation.
   12. Puncture.
   13. Abrasion.

14. Heavy Traffic.
15. Soiling, staining and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High-speed operation.
21. Improper lubrication.
22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Destructive testing.
25. Misalignment.
26. Excessive weathering.
27. Unprotected storage.
28. Improper shipping or handling.
29. Theft.
30. Vandalism.

END OF SECTION 01040

SECTION 01045 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the contract, including General and Supplementary conditions and other Division 1 specification sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for cutting and patching.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division1 Section “Coordination” for procedures for coordinating cutting and patching with other construction activities.
   2. Refer to other Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
      a. Requirements of this Section apply to mechanical and electrical installations. Refer to Division 15 sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

1.3 SUBMITTALS

A. Cutting and patching proposal: Submit a proposal describing procedures well in advance of the time cutting and patching will be performed if the Owner requires approval of these procedures before proceeding. Request approval to proceed. Include the following information, as applicable, in the proposal:
   1. Describe the extent of cutting and patching required. Show how it will be performed and indicate why it cannot be avoided.
   2. Describe anticipated results in terms of changes to existing construction. Include changes to structural elements and operating components as well as changes in the building’s appearance and other significant visual elements.
   3. List products to be used and firms or entities that will perform Work.
   4. Indicate dates when cutting and patching will be performed.
   5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out-of-service. Indicate how long service will be disrupted.
   6. Where cutting and patching involves adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with the original structure.

B. Approval by the Engineer to proceed with cutting and patching does not waive the Engineer’s right to later require complete removal and replacement of unsatisfactory work.

1.4 QUALITY ASSURANCE

A. Requirements for structural work: Do not cut and patch structural elements in a manner that would change their load-carrying capacity or load-deflection ratio.
   1. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
      a. Foundation construction.
      b. Bearing and retaining walls.
      c. Structural concrete.

d. Structural steel.
e. Lintels.
f. Timer and primary wood framing.
g. Structural decking.
h. Stair systems.
i. Miscellaneous structural metals.
j. Equipment supports.
k. Piping, ductwork, vessels and equipment.

B. Operational limitations: Do not cut and patch operating elements or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.
1. Obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety related systems:
a. Primary operational systems and equipment.
b. Air or smoke barriers.
c. Water, moisture or vapor barriers.
d. Membranes and flashings.
e. Fire protection systems.
f. Noise and vibration control elements and systems.
g. Control systems.
h. Communications systems.
i. Conveying systems.
j. Electrical wiring systems.

C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Engineer's opinion, reduce the building's aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patched in a visually unsatisfactory manner.
1. If possible, retain the original Installer or Fabricator to cut and patch the exposed work listed below. If it is impossible to engage the original Install or Fabricator, engage another recognized, experienced and specialized firm.
a. Concrete finishes.
b. Brick masonry.
c. Roofing.
d. Firestopping.
e. Window system.
f. Acoustical ceilings.
g. Carpeting.
h. Wall covering.

1.5 WARRANTY

A. Warranty: Replace, patch and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Use materials to existing materials. For exposed surfaces, use materials that visually match existing, adjacent surfaces to the fullest extent possible if identical materials are unavailable or cannot be used. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed before cutting. If unsafe or unsatisfactory conditions are encountered, take corrective action before proceeding.
   1. Before proceeding, meet at the project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedure and resolve potential conflicts before proceeding.

3.2 PREPARATION

A. Provide temporary support of work to be cut.

B. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the project that might be exposed during cutting and patching operations.

C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Avoid cutting existing pipe, conduit or ductwork serving the building but scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
   1. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.

B. Cutting: Cut existing construction using methods least likely to damage elements retained or adjoining construction. Where possible, review proposed procedures with the original Installer; comply with the original Installer’s recommendations.
   1. In general, where cutting, use hand or small power tools designed for sawing or grinding, not hammering or chopping. Cut holes and slots as small as possible, neatly to size required and with minimum disturbance of adjacent surface. Temporarily cover openings when not in use.
   2. To avoid marring existing finished surfaces, cut or drill form the exposed or finished side into concealed surface.
   3. Cut through concreate and masonry using a cutting machine such as a Carborundum saw or a diamond-core drill.
   4. Comply with requirements of applicable Division 2 Sections where cutting and patching requires excavating and backfilling.
   5. Where services are required to be removed, relocated or abandoned, by-pass utility services, such as pipe or conduit, before cutting. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after bypassing and cutting.

C. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
   1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Where removing walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform color and appearance. Remove existing floor and wall covering and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Where patching occurs in a smooth painted surface, extend final pain coat over entire unbroken surface containing the patch after the area has received primer and second coat.
5. Patch, repair or rehang existing ceiling as necessary to provide an even-plane surface of uniform appearance.

D. Plaster Installation: Comply with manufacturer's instructions and install thickness and coats as indicated.
1. Unless otherwise indicated, provide 3-coat work.
2. Finish gypsum plaster to match existing adjacent surfaces. Sand lightly to remove trowel marks and arises.
3. Cut, patch, point-up and repair plaster to accommodate other construction.

3.4 CLEANING

A. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty and similar items. Thoroughly clean piping, conduit and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION 01045

SECTION 01300 - SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for submittals required for performance of the Work, including the following:
   1. Contractor's construction schedule.
   2. Submittal schedule.
   3. Shop drawings.
   4. Product data.
   5. Samples.
   6. Quality assurance submittals.

B. Administrative submittals: Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:
   1. Permits.
   2. Applications for payment.
   3. Performance and payment bonds.
   4. Insurance certificates.
   5. List of subcontractors.

C. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 1 Section "Applications for Payment" specifies requirements for submittal of the Schedule of Values.
   2. Division Section "Coordination" specifies requirements governing preparation and submittal of required Coordination Drawings.
   3. Division1 Section "Submittals" specifies requirement for submittal of inspection and test reports.
   4. Division1 Section "Contract Closeout" specifies requirement for submittal of Project Record Documents and warranties at project closeout.

1.3 DEFINITIONS

A. Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.
   1. Preparation of Coordination Drawings is specified in Division 1 Section "Coordination" and may include components previously shown in detail on Shop Drawings or Product Data.

1.4 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, deliver, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
    a. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
3. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow enough time for submittal review, including time for resubmittals.
    a. Allow two weeks for initial review. Allow additional time if the Engineer must delay processing to permit coordination with subsequent submittals.
    b. If an intermediate submittal is necessary, process the same as the initial submittal.
    c. Allow two weeks for reprocessing each submittal.
    d. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

B. Submittal preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
1. Provide a space approximately 4 by 5 inches (100 by 125 mm) on the label or beside the title block on shop Drawings to record the Contractor's review and approval marking and the action taken.
2. Include the following information on the label for processing and recording action taken:
    a. Project name and Engineer's Project Number.
    b. Date.
    c. Name and address of the Engineer.
    d. Name and address of the Contractor.
    e. Name and address of the subcontractor.
    f. Name and address of the supplier.
    g. Name of the manufacturer.
    h. Number and title of appropriate Specification Section.
    i. Drawing number and detail references, as appropriate.
3. Submit clear and complete electronic copies.

1.5 SHOP DRAWINGS

A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawing. Standard information prepared without specific reference to the Project is not a Shop Drawing.

B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:
1. Dimensions.
2. Identification of products and materials included by sheet and detail number.
3. Compliance with specified standards.
4. Notation of coordination requirements.
5. Notation of dimensions established by field measurement.
6. Do not use Shop Drawing without an appropriate final stamp indicating action taken.

1.6 PRODUCT DATA

A. Collect product data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.

1. Mark each copy to show applicable choices and options. Where printed Product data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:
   a. Manufacturer's printed recommendations.
   b. Compliance with trade association standards.
   c. Compliance with recognized testing agency standards.
   d. Application of testing agency labels and seals.
   e. Notation of dimensions verified by field measurement.
   f. Notation of coordination requirements.
2. Do not submit Product Data until compliance with requirements of the Contract documents has been confirmed.
3. Submittals: Submit clear and complete copies written or electronic.
4. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators and others required for performance of construction activities. Show distribution on transmittal form.
   a. Do not proceed with installation until a copy of Product Data is in the Installer's possession.
   b. Do not permit use of unmarked copies of Product Data in connection with construction.
   c. Set of approved final shop drawings are required to be available for all trades on-site during construction.

END OF SECTION 01300

SECTION 01600 - MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 1 Section "Submittals" specifies requirements for submittal of the Contractor's Construction Schedule and the Submittal Schedule.
   2. Division 1 Section "Substitutions" specifies administrative procedures for handling requests for substitutions made after award of the Contract.

1.3 DEFINITIONS

A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories" and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
   1. "Products" are items purchase for incorporation into the Work, whether purchased for the project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system" and terms of similar intent.
      a. "Named products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
   2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed or installed to form a part of the Work.
   3. "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.4 SUBMITTALS

A. Product list: Prepare a list showing products specified in tabular form acceptable to the Engineer. Include generic names of products required. Include the manufacturer's name and proprietary product names for each item listed.
   1. Coordinate product list with the Contractor's construction Schedule and the Schedule of Submittals.
   2. Form: Prepare product list with the information on each item tabulated under the following column headings:
      a. Related Specification Section number.
      b. Generic name used in Contract Documents.
      c. Proprietary name, model number and similar designations.
      d. Manufacturer's name and address.
      e. Supplier's name and address.
      f. Installer's name and address.
      g. Projected delivery date or time span of delivery period.

3. Initial submittal: Within 30 days after date of commencement of the Work, submit 3 copies of an initial product list. Provide a written explanation for omissions of data and for known variations from Contract requirements.
    a. At the Contractor's option, the initial submittal may be limited to product selections and designations that must be established early in the Contract period.
4. Completed list: Within 60 days after date of commencement of the Work, submit 3 copies of the completed product list. Provide a written explanation for omissions of data and for known variations from Contract requirements.
5. Engineer's action: The Engineer will respond in writing to Contractor within 2 weeks of receipt of the completed product list. No response within this period constitutes no objection to listed manufacturers or products but does not constitute a waiver of the requirement that products comply with Contract Documents. The Engineer's response will include a list of unacceptable product selections, containing a brief explanation of reasons for this action.

1.5 QUALITY ASSURANCE

A. Source limitations: To the fullest extent possible, provide products of the same kind from a single source.
    1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the Engineer to determine the most important qualities before proceeding. Qualities may include attributes sub as visual appearance, strength, durability or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.

B. Compatibility of options: When the Contractor is given the option of selecting between 2 or more products for use on the project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

C. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces or products that will be exposed to view in occupied spaces or on the exterior.
    1. Labels: Locate required product labels and stamps on concealed surfaces, or where required for observation after installation, on accessible surfaces that are not conspicuous.
    2. Equipment nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
        a. Name of product and manufacturer.
        b. Model and serial number.
        c. Capacity.
        d. Speed.
        e. Ratings.

1.6 PRODUCT DELIVER, STORAGE AND HANDLING

A. Deliver, store and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft.
    1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
    2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft or other losses.

3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting and installing.
4. Inspect products upon delivery to ensure compliance with the Contract documents and to ensure that products are undamaged and properly protected.
5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
6. Store heavy materials away from the project structure in a manner that will not endanger the supporting construction.
7. Store products subject to damage by the elements above ground, under cover in a weather-tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

A. General product requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, new at the time of installation.
   1. Provide products complete with accessories, trim, finish, safety guards and other devise and details needed for a complete installation and the intended use and effect.
   2. Standard products: Where available, provide standard products of types that have been produces and used successfully in similar situations on other projects.

B. Product selection procedures: The Contract Documents and governing regulations govern product selection. Procedures governing product selection include the following:
   1. Proprietary Specification requirements: Where Specifications name only a single product or manufacturer, provide the product indicated.
   2. Semi-proprietary Specification requirements: Where Specifications name 2 or more products or manufacturers, provide 1 of the products indicated. No substitutions will be permitted.
   3. Where Specifications specify products or manufacturers by name, accompanied by the term "or equal" or "or approved equal," comply with the Contract Document provision concerning "substitutions" to obtain approval for use of an unnamed product.
   4. Nonproprietary Specifications: When Specifications list products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to use of these products only, the Contractor may propose any available product that complies with Contract requirements. Comply with contract Documents provisions concerning "substitutions" to obtain approval for use of an unnamed product.
   5. Description Specification Requirements: Where Specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics of and otherwise complies with Contract requirements.
   6. Performance Specification requirements: Where Specifications require compliance with performance requirements, provide products that comply with these requirements and are recommended by the manufacturer for the application indicated.
      a. Manufacturer's recommendations may be contained in published product literature or by the manufacturer's certification of performance.
   7. Compliance with standards, codes and regulations: Where Specifications only require compliance with an imposed code, standard or regulation, select a product that complies with the standards, codes or regulations specified.
   8. Visual matching: Where Specifications require matching and established Sample, the Engineer's decision will be final on whether a proposed product matches satisfactorily.
      a. Where no product available within the specified category matches satisfactorily and complies with other specified requirement, comply with provisions of the

Contract Documents concerning “substitutions” for selection of a matching product in another product category.

b. Visual selection: Where specified product requirements include the phrase “…as selected from manufacturer’s standard colors, patterns, textures…” or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Engineer will select the color, pattern and texture from the product line selected.

9. Disallowances: Refer to Individual Specifications sections and “Allowances” provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

A. Comply with manufacturer’s instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.

B. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION 01600

SECTION 01631 - SUBSTITUTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Division 1 Section “Submittals” specifies requirements for submitting the Contractor’s Construction Schedule and the Submittal Schedule.
2. Division 1 Section “Material and Equipment” specifies requirements governing the Contractor’s selection of products and product options.

1.3 DEFINITIONS

A. Definitions used in the Article do not change or modify the meaning of other terms used in the Contract Documents.

B. Substitutions: Changes in products, materials, equipment and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions. The following are not considered to be requests for substitutions:
1. Substitutions requested during the bidding period and accepted by Addendum prior to award of the Contract are included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
2. Revisions to the Contract documents requests by the Owner or Engineer.
3. Specified options of products and construction methods included in the Contract Documents.
4. The Contractor’s determination of and compliance with governing regulations and orders issued by governing authorities.

1.4 SUBMITTALS

A. Substitution Request Submittal: The Engineer will consider requests for substitution if received within 60 days after commencement of the Work. Requests received more than 60 days after commencement of the Work may be considered or rejected at the discretion of the Engineer.
1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and according to procedure required for change-order proposals.
2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
3. Provide complete documentation showing compliance with the requirements for substitutions and the following information as appropriate:
a. Coordination Information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate contractors, that will be necessary to accommodate the proposed substitution.

b. A detailed comparison of significant qualities of the proposed substitution with hose of the Work specified. Significant qualities may include elements such as performance, weight, size, durability and visual effect.
c. Product data, including Drawings and descriptions of products and fabrication and installation procedures.
d. Samples where applicable or requested.
e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
f. Cost information, including a proposal of the net change if any, in the Contract Sum.
g. The Contractor's certification that the proposed substitution conforms to requirements in the Contract documents in every respect and is appropriate for the applications indicated.
h. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

4. Engineer's action: If necessary, the Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. The Engineer will notify the contractor of acceptance or rejection of the substitution within 2 weeks of receipt of the request, or one week of receipt of additional information or documentation, whichever is later. Acceptance will be in the form of a change order.
   a. Use the product specified if the Engineer cannot make a decision on the use of a proposed substitute within the time allocated.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Conditions: The Engineer will receive and consider the Contractor's request for substitution when one or more of the following conditions are satisfied, as determined by the Engineer. If the following conditions are not satisfied, the Engineer will return the requests without action except to record noncompliance with these requirements.
   1. Extensive revisions to the Contract Documents are not required.
   2. Proposed changes are in keeping with the general intent of the Contract Documents.
   3. The request is timely fully documented and properly submitted.
   4. The specified product or method of construction cannot be provided within the Contract Time. The Engineer will not consider the request if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
   5. The request is directly related to an "or-equal" clause or similar language in the Contract Documents.
   6. The requested substitution offers the Owner a substantial advantage in cost, time. Energy conservation or other considerations, after deducting additional responsibilities the Owner must assume. The Owner's additional responsibilities may include compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner, and similar considerations.
   7. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
   8. The specifies product of method of construction cannot be provided in a manner that is compatible with other materials and where the Contractor certifies that the substitution will overcome the incompatibility.
   9. The specified product of method of construction cannot be coordinated with other materials and where the Contractor certifies that the proposed substitution can be coordinated.

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

B. The Contractor’s submittal and the Engineer’s acceptance of Shop Drawing, product data, or samples for construction activities not complying with the Contract documents do not constitute an acceptable or valid request for substitution, nor do they constitute approval.

PART 3 - EXECUTION – Not applicable

END OF SECTION 01631

SECTION 01700 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract close out including but not limited to, the following:
   1. Inspection procedures.
   2. Project record document submittal.
   3. Operation and maintenance manual submittal.
   4. Submittal of warranties.
   5. Final cleaning.
   6. Liquidated Damages for late completion.

B. Closeout requirements for specific construction activities are included in the appropriate Sections in Division 2 through 16.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
   1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
      a. Include supporting documentation for completion as indicated in these Contract documents and a statement showing an accounting of changes to the Contract Sum.
      b. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction and reasons the Work is not complete.
   2. Advise the Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
   4. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates and similar releases.
   5. Submit record drawings, maintenance manuals and similar final record information.
   6. Deliver tools, spare parts, extra stock, and similar items.
   7. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner’s personnel of changeover in security provisions.
   8. Complete startup testing of systems and instruction of the Owner’s operation and maintenance personnel. Discontinue and remove temporary facilities from the site along with mockups, construction tools and similar elements.
   9. Complete final cleanup requirement, including touch up painting.
   10. Touch up and otherwise repair and restore marred, exposed finishes.

B. Inspection procedures: Upon receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfulfilled requirements. The Engineer will prepare

the Certificate of Substantial Completion following inspection or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

1. The Engineer will repeat inspection when requested and assure that the Work is substantially complete.
2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.4 FINAL ACCEPTANCE

A. Preliminary procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
   1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operation where required.
   2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
   3. Submit a certified copy of the Engineer's final inspection list of items to be completed or corrected, endorsed, and dated by the Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Engineer.
   4. Submit final meter readings for utilities, a measure record of stored fuel and similar data as of the date of Substantial Completion or when the Owner took possession of and assumed responsibility for corresponding elements of the Work.
   5. Submit Consent of Surety to Final Payment.
   6. Submit a final liquidated damages settlement statement.
   7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Reinspection procedure: The Engineer will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Engineer.
   1. Upon completion of reinspection, the Engineer will prepare a certificate of final acceptance. If the Work is incomplete, the Engineer will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
   2. If necessary, reinspection will be repeated.

1.5 LIQUIDATED DAMAGES

A. The project shall reach Substantial Completion by January 20, 2023. Punch List Items shall be completed by February 3, 2023.

B. Contractor and Owner recognize that time is of the essence and that Owner will suffer financial loss if the Work Is not completed within the times in Paragraph 1.5A above, plus any time extensions in executed Change Orders. The parties also recognize the delays, expense, and difficulties involved in proving in a legal proceeding the actual loss suffered by Owner if the work is not completed on time. Accordingly, instead of requiring and such proof, Owner and Contractor agree that as Liquidated Damages for delay (but not as a penalty), Contractor and Contractor's Surety shall pay Owner **Two Hundred and Fifty Dollars ($250**) for each day that:
   1. Expires after the time specified in Paragraph 1.5A above for Substantial Completion, until the Work is substantially complete, as indicated on the official Certificate of Substantial Completion when issued by Con'eer Engineering, Inc through State of Montana Fish, Wildlife and Parks Department.
   2. Expires after the time specified in Paragraph 1.5A for the Completion of the Punch List items, as indicated on the official certificate of Final Acceptance when issued by Con'eer Engineering Inc through the State of Montana Fish, Wildlife and Parks Department.

C. In addition, the Contractor will be responsible for any cost incurred by the Owner to provide a temporary facility off site due to delays in the construction schedule. These costs will include, but are not limited to, transportation, facility rental, food, etc. The Liquidated Damages specified herein include unscheduled employment by the Engineer.

1.6 RECORD DOCUMENT SUBMITTALS

A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the Engineer's reference during normal working hours.

B. Record drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawing and Shop Drawing. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is more capable of showing conditions fully and accurately. Where Shop Drawing are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
1. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work.
2. Mark new information that is important to the Owner but was not shown on Contract Drawing or Shop Drawings.
3. Note related Change Order numbers where applicable.
4. Organize record drawing sets into manageable sets. Bind sets with durable paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.

C. Record Specifications: Maintain one complete copy of the project manual, including Addenda. Include with the project manual one copy of other written construction documents, such as Change Orders and modifications issued in printed form during construction.
1. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
3. Note related record drawing information and product date.
4. Upon completion of the Work, submit record Specifications to the Engineer for the Owner's records.

D. Record product date: Maintain one copy of each product data submittal. Note related Change Orders and markup of record drawing and Specifications.
1. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site and from the manufacturer's installation instructions and recommendations.
2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
3. Upon completion of markup, submit complete set of record product data to the Engineer for the Owner's records.

E. Record sample submitted: Immediately prior to Substantial Completion, the Contractor shall meet with the Engineer and the Owner's personnel at the project site to determine which samples are to be transmitted to the Owner for record purposes. Comply with the Owner's instruction regarding deliver to the Owner's sample storage area.

F. Miscellaneous record submittals: Refer to other specification Sections for requirements of miscellaneous record keeping and submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous

record, and place in good order. Identify miscellaneous records properly and bind or file, ready for continued use and reference. Submit to the Engineer for the Owner's records.

G. Maintenance manuals: Organize operation and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual, heavy-duty, 2" (51mm), 3-ring, vinyl covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:
1. Emergency instructions.
2. Spare parts list.
3. Copies of warranties.
4. Wiring diagrams.
5. Recommended "turn-around" cycles.
6. Inspection procedures.
7. Shop Drawing and product data.
8. Fixture lamping schedule.

PART 2 - PRODUCTS Not applicable.

PART 3 - EXECUTION

3.1 CLOSEOUT PROCEDURES

A. Operation and maintenance instructions: Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
1. Maintenance manuals.
2. Record documents.
3. Spare parts and materials.
4. Identification systems.
5. Control sequences.
6. Hazards.
7. Cleaning.
8. Warranties and bonds.
9. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:
1. Startup.
2. Shutdown.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

3.2 FINAL CLEANING

A. General: The General Conditions require general cleaning during construction. Regular site cleaning is included in Division 1.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion.
    a. Remove labels that are not permanent labels.
    b. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken class and other damaged transparent materials.
    c. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition. Leave concrete floors broom clean. Vacuum carpeted surface.
    d. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
    e. Clean the site, including landscape development areas, of rubbish, litter and other foreign substances. Sweep paved areas broom clean, remove stains, spills and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth, even-textured surface.

C. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner’s property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the site and dispose of lawfully.
    1. Where extra materials of value remain after completion of associated Work, they become the Owner’s property. Dispose of these materials as directed by the Owner.

END OF SECTION 01700

SECTION 01732 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Demolition and removal of selected site elements.
   2. Salvage of existing items to be reused or recycled.

B. Related Work: Section 01734 – Waste Management

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and re-installed.

B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed, and salvaged, or removed and reinstalled.

1.3 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity, interruption of utility services, use of elevator and stairs, and locations of temporary partitions and means of egress.

B. Pre-demolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations.

1.4 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of Authorities Having Jurisdiction.

C. Standards: Comply with ANSI A 10.6 and NFPA 241.

1.5 PROJECT CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner’s operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practical.

C. Before selective demolition, the Owner will remove the following: Movable casework, furniture and any loose items.

D. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

PART 2 - PRODUCTS – Not Applicable

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the conditions of items to be removed and reinstalled, and those items to be removed and salvaged.

D. When unanticipated mechanical, electrical or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

E. Engage a Professional Engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs.

G. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/Systems Requirements: Locate, identify, disconnect and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Arrange with the utility companies to shut off indicated utilities.

2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition, provide temporary services/systems that bypass areas of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways and other adjacent occupied and used facilities.
1. Comply with requirements for access and protection specified in Division 1 Section “Construction Facilities and Temporary Controls”.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Neatly cut openings and holes plumb, square and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Do not use cutting torches until work is cleared of flammable materials. At concealed spaces such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Removed and Reinstalled Items
1. Clean and repair items to functional condition adequate for intended use. Paint equipment to match new equipment.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Project items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports and miscellaneous materials necessary to make items functional for use indicated.

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable,

protected storage location during selective demolition. Then clean and reinstall in their original locations after selective demolition operations are complete.

3.5 DISPOSAL OF REMOVED MATERIALS

A. Except for items or materials indicated to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner’s property, removed materials shall be removed from Project site.

B. Burning of removed or demolished materials is prohibited.

C. Transport demolished materials off Owner’s property and legally dispose of them in an EPA-approved landfill. Comply with requirements specified in Section 01734.

3.6 CLEANING

A. Clean adjacent structures and improvements of dust, dirt and debris caused by the selective demolition operations. Return adjacent areas to condition existing before the selective demolition operations began.

END OF SECTION 01732

SECTION 01734 - WASTE MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for reduction and disposal of waste material produced by construction operations.

B. Related work:
1. Section 01732 - Selective Demolition

1.2 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitability, corrosivity, toxicity, or reactivity.

D. Non-hazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitability, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and re-manufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for re-manufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become separated.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.3 WASTE MANAGEMENT PERFORMANCE REQUIREMENTS

A. Owner requires the Contractor to manage construction operations in a manner that minimizes the amount of trash and waste produced.

B. Employ processes that minimize the generation of waste due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
1. Aluminum and plastic beverage containers.
2. Corrugated cardboard.
3. Wood pallets.
4. Clean dimensional wood: May be sued as blocking or furring.
5. Land clearing debris, including brush, branches, logs and stumps.
6. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.

E. Methods of trash/waste disposal that are note acceptable are:
1. Burning on the project site.
2. Burying on the project site.
3. Dumping or burying on other property, public or private.
4. Other illegal dumping or burying.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, State and local requirements pertaining to legal disposal of all construction and demolition waste materials.

PART 2 - PRODUCTS – Not used.

PART 3 - EXECUTION

3.1 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste management Plan to job site foreman, each subcontractor, Owner and the Engineer.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate state of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Pre-Construction meeting.
   2. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return and trash disposal, for use by all contractors and installers.
   1. As a minimum, provide:
      a. Separate area for storage of materials to be reused on site, such as wood cutoffs for blocking.
      b. Separate dumpsters for each category of recyclable.
      c. Recycling bins at worker lunch area.
   2. Provide containers as required.
   3. Provide adequate space for pick-up and delivery and convenience to subcontractors.
   4. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: At the project site, separate, store, protect, and handle identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort and protect products to be salvaged for reuse off-site.

END OF SECTION 01734

SECTION 01740 - WARRANTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for warranties required by the Contract Documents including manufacturer's standard warranties on products and special warranties.
   1. Refer to the General Conditions for terms of the Contractor's period for correction of the Work.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 1 Section “Submittals” specifies procedures for submitting warranties.
   2. Division 1 Section “Contract Closeout” specifies contract closeout procedures.
   3. Certifications and other commitments and agreements for continuing service to Owner are specifies elsewhere in the Contract Documents.

C. Disclaimers and limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers and subcontractors required to countersign special warranties with the Contractor.

1.3 DEFINITIONS

A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.4 WARRANTY REQUIREMENTS

A. Related damages and losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure, or must be removed and replaced to provide access for correction of warranted construction.

B. Reinstatement of warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefitted from use of the Work through a portion of its anticipated useful service life.

D. Owner's recourse: Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights or remedies.

E. The Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

F. Where the Contract Documents require a special warranty or similar commitment on the Work or part of the Work, the Owner reserves the right to refuse to accept the Work until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

1.5 SUBMITTALS

A. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
   1. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within 15 days of completion of that designated portion of the Work.

B. When the Contract Documents require the Contractor, or the Contractor and a subcontractor, supplier or manufacturer to execute a special warranty, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner, through the Engineer, for approval prior to final execution.

C. Form of submittal: At Final Completion compile 2 copies of each required warranty properly executed by the Contractor, or by the Contractor, subcontractor, supplier or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the project manual.

D. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring, vinyl-covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½ by 11-inch paper (115 by 280 mm) paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address and telephone number of the Installer.
   2. Identify each binder on the front and spine with the typed or printed title "WARRANTIES", Project title or name, and name of the Contractor.
   3. When warranted construction requires operation and maintenance manuals, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

END OF SECTION 01740

SPECIFICATIONS - DIVISION 15 - MECHANICAL

DIVISION 15 – MECHANICAL

TABLE OF CONTENTS

SECTION 15010 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DOCUMENTS

A. The provisions, terms and requirements of Instruction to Bidders, General Conditions, and Supplementary Conditions and the Applicable Drawings and Technical Specifications herein apply to work under this Division.

B. Drawings are partly diagrammatic, and do not necessarily show the exact location of piping and ductwork.

C. Risers and other diagrams are schematic only, not to scale, and do not necessarily show the physical arrangement of the equipment. Do not use riser diagrams to obtain lineal runs.

D. Specifications are of the abbreviated or "streamlined" type and include incomplete sentences. Omissions of words or phrases such as "the Contractor shall", "in conformity with", "shall be", etc., are intentional. Omitted words or phrases shall be supplied by inference.

1.2 SCOPE

A. This work consists of, but is not necessarily limited to, the furnishing of all plant, labor, equipment, appliances and materials and the performance of all operations in connection with the installation of all mechanical work complete, in strict accordance with specifications and/or drawings, including incidentals necessary and required for their completion.

B. Note alternates listed and account for any change in the work and include any price deemed necessary to meet the requirements of the respective alternate. See General Requirements for Schedule of Alternates.

1.3 WORKMANSHIP

A. Workmanship shall be by workers skilled in particular trade in conformance with best practices.

B. Work shall contribute to efficiency of operation, access, maintenance, appearance. No part of installation shall interfere with operation of any other system or parts of building.

C. Materials or equipment not properly installed or finished shall be repaired or replaced as hereinafter provided under Guaranty-Warranty.

D. Guaranty-Warranty - See General Conditions for work under this Section, and mechanical sections within where special warranty conditions are noted.

1.4 RESPONSIBILITY

A. The Contractor shall be responsible for installation of satisfactory and complete piece of work in accordance with intent of drawings and specifications, providing all incidental items required for completion of work whether specifically mentioned or indicated.

B. Consult all drawings for project, shop drawings of other trades, and verify building dimensions to predetermine that work and equipment will fit as intended.

C. Check location of piping, ducts, equipment, etc., to verify clearance from all openings, structural members, cabinets, lights, outlets, equipment having fixed locations, etc., and proper concealment above, behind or within finished surfaces. Coordinate with Electrical Contractor; maintain clearance required by NEC from electrical panels.

D. Changes in the location of pipes, ducts, equipment, etc., necessary due to obstacles or work of other trades shall be made only after approved by Engineer.

E. Prior to submitting bid, visit site of project and ascertain conditions affecting proposed work and make allowances as to cost thereof.

1.5 COORDINATION

A. Coordinate the work to proceed with minimum interference with other trades.

B. Inform General Contractor of all openings required in building structure for installation of work.

C. Check all dimensions of equipment installed or provided by others so correct clearance and connections can be made.

D. Electrical wiring diagrams and instructions shall be provided in ample time, so equipment can be properly wired.

1.6 PROJECT CONDITIONS OR SITE CONDITIONS

A. Permits and Testing
1. The Contractor shall pay for all permits or fees in connection with the Work.

B. Temporary Water and Heat
1. See Specifications Group, General Requirements Subgroup.
2. Contractors must maintain existing HVAC equipment throughout construction.

C. Existing Conditions
1. The work shall be coordinated with existing conditions.
2. Prior to submitting bid, visit site of project and ascertain conditions affecting proposed work and make allowances as to cost thereof.

D. Remodeling
1. Construction operations will coincide with the Owner’s continued occupancy and use of the building.
2. Connections and work within existing building shall be performed with minimum inconvenience to Owner.
3. Whenever existing systems (plumbing, heating, service lines, piping, ducts, controls, etc.,) are cut into, removed, or interrupted because of the contract work, they shall be replaced, repaired, rerouted, extended or relocated as necessary to maintain operation of equipment and serve areas that remain.
4. Before any system is put out of service, the shut-off period shall be scheduled at a time acceptable to and approved by the Owner. Consult with the Owner in sufficient time for him to make necessary preparations for the shut-off period.

PART 2 - PRODUCTS

2.1 REMODELING

A. All Materials used shall be as specified under Division 15.

B. Existing system branch piping shall be capped with like materials and methods in complete accord with IMC.

PART 3 - EXECUTION

3.1 OPENINGS

A. Openings in pipes and ducts shall be kept closed during progress of work. Clean systems found dirty to satisfaction of Engineer and at no additional cost.

3.2 CUTTING, PATCHING AND FRAMING

A. Chases, openings, sleeves, hangers, anchors, recesses, equipment, pads, framing for equipment, are provided by others only as shown on Architectural or Structural Plans. If not shown on Architectural or Structural Plans, they are provided by the Mechanical Contractor for his work.

B. Mechanical Contractor shall be responsible for correct size and locations of chases, equipment pads, curbs, etc., whether provided by Mechanical Contractor or others.

C. Cutting of structural members is not permitted without consent of Engineer or Structural Engineer and under supervision of General Contractor.

D. Mechanical cutting and patching that is required for the installation of work is the responsibility of the Mechanical Contractor but done only by the General Contractor in finished work.

3.3 ACCESS AND CLEARANCE

A. Provide access and clearance to valves, coils, dampers, equipment, and items requiring service; including access doors through ceilings and walls where required. All required access doors are not indicated on the drawings but are required to be provided by MC. Location of doors shall be coordinated with the Engineer prior to installation.

3.4 PAINTING

A. Mechanical equipment shall be provided with standard finish and color; except that if manufacturer has no standard finish, equipment must have prime coat of paint. Note exceptions where specific finish or color or choice is specified.

END OF SECTION 15010

SECTION 15015 - LOCAL CONDITIONS

PART 1 - GENERAL

1.1 PERMITS AND TESTING

A. The Contractor shall pay for all permits or fees in connection with the work.

B. Any system development fees shall be paid by the Owner.

1.2 CODES AND STANDARDS

A. All work shall be in accordance with applicable local, state, and national codes and ordinances; including, but not limited to the latest legally enacted editions of the following:
International Building Code (IBC)
International Fire Code (IFC)
International Mechanical Code (IMC)
International Plumbing Code (IPC)
National Electrical Code (NEC)

B. The following references infer that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
American National Standards Institute (ANSI)
American Sanitary Association (ASA)
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
American Society of Mechanical Engineers (ASME).
American Society for Testing and Materials (ASTM)
National Fire Protection Association (NFPA)
National Sanitation Foundation (NSF)
Sheet Metal and Air Conditioning National Contractors Association (SMACNA)
Underwriters Laboratories, Inc. (UL)
Factory Mutual (FM)

1.3 ALTERATIONS

A. Changes or revisions may be made to suit job conditions if such changes meet local codes and make for an equal or better job. Review such modifications with Engineer prior to implementation.

PART 2 – PRODUCTS Not applicable

PART 3 – EXECUTION

3.1 CLEAN-UP

A. Clean labels, stains, etc. from equipment.

B. Clean equipment of dirt and debris including interior of heating units, ducts, drains, piping and fans.

C. Upon completion of work, remove materials, scraps, etc., related to the work and leave premises, including all tunnels, attics, ceilings and crawl spaces in clean and orderly conditions.

END OF SECTION 15015

SECTION 15020 – MATERIALS GENERAL

1.1 SUBSTITUTION OF MATERIALS

A. See Division 1, General Requirements

B. Except where noted as "equivalents acceptable" or "or equal", material or equipment specifically identified by manufacturer's name, model, or catalog number are open for substitution prior to bid opening only.

1. To be considered, requests for approval must;

a. Be originals, sent by mail or delivery, accompanied by the Substitution Request Form. **Requests will NOT be accepted by FAX.**

b. Include, in duplicate, manufacturer's descriptive literature and technical data sufficient to enable evaluation of equivalence to be specified materials.

c. Be received no less than seven (7) calendar days prior to the date set for the bid opening.

2. If written verification of approval/disapproval is desired, a self-addressed, stamped envelope must be included.

3. No approval is considered final until listed in an addendum to the contract documents.

C. Where substituted equipment requires ductwork, piping or electrical work differing from the basic design, the cost of all changes, including re-design, is the responsibility of the Contractor using the equipment.

1.2 RESPONSIBILITIES

A. Provide for delivery and storage of required materials. Store equipment and materials such that they are protected, easily checked and inspected.

B. Arrange with General Contractor for introduction of equipment too large to pass through finished openings.

C. Protect materials and equipment installed under this Contract and protect materials and equipment of others from damage as result of this work.

D. Material and equipment shall be installed, connected, erected, used, cleaned and conditioned as directed by manufacturer unless herein specified otherwise.

1.3 SUBMITTALS

A. See Division 1, General Requirements.

B. Within thirty (30) days of the award of Contract the prime Mechanical Contractor shall provide Submittals for the materials to be provided. Submittals for each portion of work (i.e. plumbing

fixtures, heating units, air distribution equipment, temperature controls, etc.) shall be bound in booklet form with all items in order consistent with specifications and/or schedules.

C. To be reviewed each submittal must:

1. Be originals sent by mail or deliver, with transmittal letter identifying specifications section for material submitted. **Submittals will NOT be accepted by FAX.**

2. Have Contractor's signature on one (1) copy minimum attesting to the correctness and compliance of the Submittal. Submittals shall be marked with date.

3. Include Shop Drawings detailing any engineering changes necessary to implement installation of substituted materials.

D. Product Data shall include manufacturer's literature indicating manufacturer, specific items used, sizes, dimensions, capacities, rough-in requirements, installation, maintenance, lubrication, operating instructions, and wiring diagrams.

E. Shop Drawings shall provide complete details of the proposed layout and installation of equipment and systems as specifically required for this project.

F. Submittals for equipment items crucial to the schedule of construction shall include estimated delivery schedules.

G. Provide enough copies for job use and distribution. Engineer will retain two (2) copies. One reviewed copy of all operating equipment to be tested shall be provided to the Testing and Balancing Subcontractor.

H. Submittals marked "Revise and Resubmit" shall be changed and resubmitted until correct and/or complete enough for review. Resubmittals shall be properly marked with date.

I. Review of Submittals shall not relieve Contractor from responsibility for deviations from drawings, or specifications unless he has in writing called Architect's or Engineer's attention to such deviations and secured his written acknowledgment, nor shall it relieve him from responsibility for errors in Submittals or literature.

J. Schedule:

SUBMITTAL SCHEDULE

SPEC. SECTION	MECHANICAL MATERIAL DESCRIPTION	PROD DATA	SHOP DRWG	IO&M BOOK	WIRE DIAG
15030	Firestopping	X	X	X	
15060	Hangers and Supports	X			
15100	Pipe and Fittings	X	X		
15110	Manual Valves	X	X		
15120	Pipe Specialties	X	X	X	
15130	Pumps	X	X	X	X
15180	Heating and Cooling Piping Specialties	X	X	X	

SUBMITTAL SCHEDULE					
SPEC. SECTION	MECHANICAL MATERIAL DESCRIPTION	PROD DATA	SHOP DRWG	IO&M BOOK	WIRE DIAG
15510	Boilers	X	X	X	X
15900	Energy Management & Control Systems	X	X	X	X

END OF SECTION 15020

SECTION 15030 - FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes firestopping for penetration seals of all mechanical system openings in fire rated floors, walls and assemblies, and smoke barriers, to ensure an effective barrier of the required rating.

B. Related Work:

1. UL Assembly number of fire and smoke rated assemblies shall be as specified or indicated on the general construction drawings.

1.2 SYSTEM DESCRIPTION

A. Firestopping materials and systems must fill openings in fire resistive assemblies created by penetrating mechanical systems and must be capable of closing or filling through-openings created by the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials; or deflection of pipes or sheet metal due to thermal expansion.

B. Firestopping systems shall resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM E 84 Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E 119 Method of Fire Tests of Building Construction and Materials
3. ASTM E 814 Test Method for Fire Tests of Through-Penetration

B. Underwriters Laboratory, Inc. (UL):
1. UL 723 Surface Burning Characteristics of Building Materials
2. UL 1479 Fire Tests of Through-Penetration Firestops
3. UL 2079 Test for Fire Resistance of Building Joint Systems
4. UL Fire Resistance Directory
5. UL Building Materials Directory.

1.4 SUBMITTALS

A. Product Data: Manufacturer’s literature for each type of firestopping material indicating product characteristics, typical uses, performance and limitation criteria, and test data.

B. Shop Drawings: Manufacturer's detail drawing of each type of penetration indicating UL Tested System number, and all installation requirements.

C. Warranty: Submit written guarantee for repair or replacement of systems which fail in any manner not clearly specified by manufacturer's submitted data as an inherent quality of the

material for the exposure indicated. The guarantee period shall be one year from date of substantial completion.

1.5 QUALITY ASSURANCE

A. Materials shall be UL listed, compliant with applicable codes, and tested in accordance with test methods as follows:
   1. Surface Burning Characteristics: ASTM E 84
   2. Fire Resistance Ratings: ASTM E 119
   3. Combustion Characteristics: ASTM 136
   4. Through Penetration Rating: ASTM E 814

B. Materials shall have ratings less than flame spread of 25 and smoke developed of 50 as determined in accordance with ASTM E 84.

C. Comply with product specific requirements for storage, handling, area usage, electronic interference and exposure. Maintain identification labels on materials in use or storage.

D. Copies of submittals shall be kept on site and accessible to Inspectors for the Authority Having Jurisdiction, the Architect/Engineer, and designated Owner's Representatives.

E. Qualifications
   1. Installation shall be performed by craftsman trained to perform the work of this section.
   2. Installation shall be performed by a firestopping subcontractor whose personnel have received specialized training and certification or approval from the proposed fire-stopping manufacturer. Subcontractor shall have a minimum of three years' experience installing firestopping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equivalent products of Enerstop Systems, Hilti Systems, Johns Manville, U.S.G., RectorSeal, STI and 3M are acceptable.

2.2 REQUIREMENTS

A. Firestopping materials shall be free of asbestos and lead and shall not incorporate nor require the use of hazardous solvents.

B. Firestopping materials must be flexible, allowing for normal pipe movement or sheet metal deflection.

C. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.

D. Firestopping materials shall be moisture resistant and may not dissolve in water after curing.

E. Firestopping materials shall be UL rated for assembly indicated as determined in accordance with UL listings.

2.3 DESCRIPTION

A. Materials may include:
1. Intumescent Sealants and Caulks
2. Latex Sealant
3. Elastomeric Water Based Sealant
4. Silicone Sealants and Caulks
5. Moldable Putty
6. Collars
7. Wrap Strips
8. 2-Part Silicone Foam
9. Firestopping Mortar
10. Firestopping Pillows
11. Elastomeric Spray
12. Intumescent Spray Mastic
13. Endothermic Spray Mastic
14. Forming/Damming Materials

B. Intumescent material shall be capable of expanding up to 10 times when exposed to temperatures beginning at 250 deg. F. Material shall have approved ratings to 4 hours per ASTM E 814 (UL 1479).

PART 3 - EXECUTION

3.1 GENERAL

A. Verify the location, rating and appropriate construction of all fire or smoke rated assemblies as indicated on the architectural drawings.

B. Install in all open penetrations and in the annular space in all through-penetrations in any bearing or non-bearing fire or smoke rated barrier.

C. Install in all penetrations of the membrane of rated walls, floors or ceilings.

3.2 INSTALLATION

A. Install penetration seal materials in accordance with printed instructions of the UL Fire. Resistance Directory and the manufacturer's instructions.

B. Provide metal wrap on all insulated pipe and polybutylene pipe.

C. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.

D. Protect materials from damage on surfaces subject to traffic.

E. Damming or packing materials shall be used when required to properly contain firestopping materials within openings. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestopping system.

3.3 CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim excess materials as required.

C. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

END OF SECTION 15030

SECTION 15035 - CLOSEOUT

PART 1 - GENERAL

1.1 GENERAL

A. See Division 1, General Requirements.

B. Provide all documentation prior to request for final payment.

PART 2 - PRODUCTS – Not applicable

PART 3 - EXECUTION

3.1 SUBSTANTIAL COMPLETION

A. Review list items corrected, completed or modified to meet project requirements. Provide written summary of the action response to each item. If all items listed are not addressed within thirty (30) working days of issue of Substantial completion punch list the project shall be considered not complete and shall be subject to Liquidated Damages.

3.2 OPERATING INSTUCTIONS

A. Provide instruction as to function, operation, maintenance and adjustment of each equipment item and system provided. Instructional period shall be scheduled with the Owner and arranged to include all personnel designated by the Owner. Notify the Engineer when the instruction period is scheduled.

B. Contractor shall provide Agenda prior to scheduling instructional session with the Owner.

3.3 BROCHURE OF EQUIPMENT

A. Upon completion of work, prepare two (2) copies of Brochure of Equipment containing data pertinent to equipment and systems on job, in one or more three-ring-binders sufficient to hold all literature. Provide (1) electronic version on a flash drive for the Owner use. Binders shall contain the following sections filed under separate headings:
   1. Warranty: Provide letter of Warranty for mechanical system on Mechanical Contractor's letterhead and signed by authorized representative of Mechanical Contractor.
   2. Suppliers: Provide list of subcontractors and equipment suppliers. List to be complete including address, phone number and contact person.
   3. Parts List: Provide complete parts list for all devices and equipment components. Identify by manufacturer's name and part number, and list names and addresses of suppliers of replacement parts.
   4. Copies of Submittals: Provide copies of each submittal filed under divider heading according to specification section.
   5. Installation, Maintenance, and Operating Instructions: Provide wiring diagrams, Installation, Maintenance and Operating Instructions for each piece of equipment.

6. Start-up Reports: Provide start-up reports on manufacturer-supplied forms. Forms shall indicate start-up technicians and their qualifications. In this section Pre and Post Glycol solution test results should be included.
7. Balance Reports: Tabulate Air system balance reports on standard AABC or SMACNA forms.
8. Temperature Control Drawings: Provide updated shop drawings showing all engineering changes and field modifications. All setpoints determined by Test and Balance, or by coordination with Owner or Engineer, shall be recorded. Include copies of Test and Balance check lists and duct pressure test results.

3.4 OWNER'S RECORD DRAWINGS

A. Submit prints clearly marked with the changes recorded on the "Record Drawings" defined in Section 15010, 3.5, for review by the Engineer. These drawings, when accepted as complete, will be delivered to the Owner by the Engineer as "As-Built Record Drawings".

END OF SECTION 15035

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Mechanical supports for piping systems.

PART 2 - PRODUCTS

2.1 HANGERS

A. Bare Pipe:
   1. Copper: Adjustable swivel ring, copper plated steel, ½" to 4", similar to Grinnell Fig. CT-69.
   2. Black Steel: Adjustable swivel ring, zinc plated carbon steel, ½" to 8", similar to Grinnell Fig. 69.
   3. Galvanized Steel: Adjustable swivel ring, zinc plated carbon steel, ½" to 8", similar to Grinnell Fig. 69.
   4. Plastic: Adjustable swivel ring, zinc plated carbon steel, ½" to 8", similar to Grinnell Fig. 69.

B. Insulated Pipe: Adjustable Clevis, black carbon steel, sized for outside diameter of insulation, 2" to 30", similar to Grinnell Fig. 260, with insulation protection shield, galvanized carbon steel, similar to Grinnell Fig. 167.

C. Floor Supports: Riser clamps, black carbon steel, 3/4" to 20", similar to Grinnell Fig. 261.

D. Wall Bracketed Pipes: Unistrut, or equivalent, channels anchored to wall with clamps on each pipe. Clamps for insulated pipes shall be sized for the pipe and insulation.

E. Multiple Pipes: Unistrut, or equivalent, channels suspended with threaded rod may be used in lieu of individual hangers to support multiple parallel pipes with clamps on each pipe. Clamps for insulated pipes shall be sized for the pipe and insulation, with insulation protection shields, galvanized carbon steel, similar to Grinnell Fig. 167.

2.2 SLEEVES

A. Steel in concrete and block.

B. PVC below concrete floors.

2.3 PIPE STANDS

A. Steel pipe, no less than 2 sizes smaller than pipe to be supported, with square steel base plate, similar to B-Line Figure B3088, with steel pipe saddle support, similar to B-Line Figure 3095. Saddles for pipe sized for both pipe and insulation, with insulation protection shield, galvanized carbon steel, similar to B-Line B3154.

2.4 PIPE CLAMPS

A. Unistrut or equal sized for both pipe and insulated pipe isolator.

PART 3 - EXECUTION

3.1 HANGERS

A. Provide hangers for all piping as specified. Straps are not acceptable. Support pipe horizontally as follows:
   1. Copper (Domestic, Heating Water): 6'-0" o.c. 1½" and smaller; and 10'-0" o.c. 2" and larger.
   2. PVC & CPVC Plastic (All Services): 4'-0" o.c. all sizes.
   3. Steel Pipe Screwed (Water): 10'-0" o.c. 3/4" and smaller and 12'-0" o.c. 1" and larger.
   4. Steel Pipe Welded (Water): 12'-0" o.c.
   5. Steel Pipe Mechanically Coupled: Spacing as recommended by system manufacturer, minimum one hanger on each horizontal pipe section in addition to spacing required by service.

B. Provide inserts in structures as necessary for support of piping.

3.2 SUPPORTS

A. Provide supports for all piping as specified. Straps are not acceptable. Support pipe vertically as follows:
   1. Copper (Domestic, Heating Water): At each floor (not to exceed 10 ft. spacing).
   2. PVC and CPVC plastic (All Services): Base and each floor. Provide mid-story guides. Provide for expansion every 30 ft.
   3. Steel pipe screwed (Water): Every other floor (not to exceed 25 ft. spacing).
   4. Steel pipe welded (Water): Every other floor (not to exceed 25 ft. spacing).
   5. Mechanically coupled steel pipe: To be supported as recommended by manufacturer.
   6. Steel pipe (Natural Gas): ½" every 6 ft; 3/4" and 1" every 8 ft; 1¼" and larger every floor level.

3.3 SLEEVES

A. Sleeves for pipe shall be sized for both pipe and insulation except for pipes penetrating fire rated construction and exposed pipe through floor to radiation units. Sleeves shall be routed through and tack welded to steel floor deck, preset in concrete walls and floors and grouted in block walls.

3.4 PIPE STANDS

A. Set pipe stand straight and plumb. Arrange for level and flat bearing for base plate, grout as required. Cut pipe to length for firm support of piping without springing pipe fittings.

3.5 PIPE CLAMPS

A. Pipes shall be supported outside the pipe insulation on inserts and metal saddles for free movement of pipe lengths.

END OF SECTION 15060

SECTION 15080 – MECHANCIAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

1.3 QUALITY ASSURANCE

A. Contractor’s Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jacket, coverings, sealers, mastics, and adhesives) with a flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

C. Paper laminate jackets shall be permanently fire and smoke resistant, unaffected by water or humidity.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data and installation instructions for each type of mechanical insulation.

B. Schedule showing manufacturer’s product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

C. Manufacturer’s recommended installation method.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer’s stamp or label affixed showing fire hazard indexes of products.

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. Fiberglass

1. Product of Johns Manville listed. Equivalent Certainteed, Knauf, and Fiberglas acceptable.
2. MICRO-LOK glass fiber insulation: long, flame attenuated glass fibers bonded with a thermosetting resin. One-piece “hinged” construction for easy installation.
3. Jacketing: AP-T Plus all purpose jacket of white Kraft bonded to aluminum foil and reinforced with fiberglass yarn. Longitudinal lap of pressure sensitive tape.
4. Fittings: Zeston 25/50 premolded one-piece PVC insulated fitting covers.

Fluid Design Operating Temperature Range °F	Insulation Conductivity Range	Fluid Type	Run-outs up to 2”	1” and Less	1-1/2 to 2”	2-1/2 to 4”	5 &6”	8” and Up
141-200°F	0.25-0.29	Heating	0.5	1.5	2.0	2.0	2.0	2.0
105°F & Up	0.24-0.28	Domestic Hot	0.5	1.0	1.0	1.5	1.5	
	0.24-0.28	Domestic Cold	0.5	1.0	1.0	1.0	1.0	

5. Thickness as scheduled, except ½” thick within interior walls and through header plates, only where space is limited and does not permit scheduled thickness.
6. Zeston 2000 PCV cut and curled jacketing, 15 ml thickness, UL 25/50 rating, immune to galvanic or electrolytic corrosion.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Contractor or Architect/Engineer.

B. All Piping shall be pressure tested prior to insulation.

C. All ductwork shall be properly sealed and/or leak tested prior to insulation.

3.2 PIPING INSULATION

A. Plumbing System Application Requirements:
1. Insulate the following cold plumbing piping systems:
   a. All modified domestic cold-water piping.
2. Insulate the following hot plumbing piping systems:
   a. All modified domestic hot water piping.
   b. All modified domestic hot water recirculating piping.
3. Exceptions: Insulation is not required on:
   a. Chrome-plated fixture supply piping.
   b. Air chambers.
   c. Unions.
   d. Strainers.
   e. Check valves.
   f. Balancing valves.
   g. Drain valves from water coolers.
   h. Storm drain piping located in crawlspaces or tunnels.
   i. Buried piping.
   j. Fire protection piping.
   k. Pre-insulated piping in equipment.

3.3 HVAC PIPING SYSTEM INSULATION

A. Insulation Omitted: Insulation on hot piping within radiation enclosures; and unions on hot piping; flanges on hot piping; strainers on hot piping; balancing valves on hot piping; and flexible connections on hot piping.

B. Heating piping:
1. Application Requirements: Insulate the following hot low-pressure HVAC piping systems:
   a. All HVAC hot water supply and return piping.
   b. Patch and repair all existing piping insulation found within construction area.
2. Insulate each piping system specified above with the type and thickness of insulation listed above.
3. Wrap all piping located within small equipment cabinets to prevent condensation dripping.

3.4 INSTALLATION OF PIPING AND EQUIPMENT INSULATION

A. General: Install insulation products in accordance with manufacturer's written instruction, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete runs. DO NOT use cut pieces or scraps abutting each other.

C. Clean and dry pipe surfaces prior to insulation. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier jackets on pipe insulation and protect from puncture or other damage.

E. Cover valves, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units.

F. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

G. Butt insulation against pipe hanger insulation inserts. For hot pip, apply 3" wide vapor barrier tape or band over butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints with 3" wide vapor barrier tape or band.

H. Piping exposed to weather: Protect outdoor insulation from weather by installation of weather barrier jacketing, as recommended by the manufacturer.

I. Apply piping cement to terminate ends of all insulation.

J. Tape insulation should be applied with a spiral wrap to obtain a 50% overlap. To insulate valves, tees and other fittings, small pieces of tape should be cut to size and pressed into place, with no metal exposed. The fitting then is additionally over-wrapped with longer lengths for a durable finish.

K. Hanger inserts shall be installed under the pipe at hanger external to the insulation; at Unistrut clamps and at trapeze supports. Thickness to be equal to the adjoining insulation with vapor barrier seals for cold surfaces.

3.5 INSTALLATION OF PIPING AND EQUIPMENT INSULATION

A. General: Install insulation products in accordance with manufacturer's written instruction, and in accordance with recognized industry practices to ensure that insulation services its intended purpose.

B. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete runs. DO NOT use cut pieces or scraps abutting each other.

C. Clean and dry pipe surfaces prior to insulation. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier jackets on pipe insulation and protect from puncture or other damage.

E. Cover valves, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units.

F. Extend piping insulation without interruption through walls; floors and similar piping penetrations, except where otherwise indicated. Heating piping insulation should extend to individual unit isolation valves or within 2' of coil, whichever is closest.

G. Butt insulation against pipe hanger insulation inserts. For hot pipe, apply 3" wide vapor barrier tape and band over butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints with 3" wide vapor barrier tape or band.

H. Piping exposed to weather: Protect outdoor insulation from weather by installation of weather barrier jacketing as recommended by the manufacturer. Fiberglass insulation is NOT PERMITTED where exposed to weather.

I. Apply piping cement to terminate ends of all insulation.

J. Tape insulation should be applied with a spiral wrap to obtain a 50% overlap. To insulate valves, tees and other fittings, small pieces of tape should be cut to size and pressed into place, with no metal exposed. The fitting then is additionally over-wrapped with longer lengths for a durable finish.

END OF SECTION 15080

SECTION 15095 - ACCESS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes access doors for adjustment and service of mechanical equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Product of Cesco. Equivalents acceptable. Minimum size 24" x 24", except where structure dictates a smaller size.

2.2 ALL PURPOSE STYLE W

A. Galvanized bonderized steel with prime coat, 16-gauge frame, 14-gauge panel. Concealed continuous zinc plated hinge. Flush mounted cam latch. For use in non-rated construction only.

2.3 FIRE RATED STYLE FB

A. Galvanized bonderized steel with prime coat, 16-gauge frame, 20-gauge panels with fire resistive insulation and automatic door closure, concealed continuous galvanized steel hinge with SS pin. Flush mounted cam latch. UL rated 1-1/2 hour for 2-hour systems.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide access doors in ceilings and walls where required for access to valves, coils, dampers, water hammer arresters and equipment. Coordinate locations with equipment and work of other trades.

END OF SECTION 15095

SECTION 15100 - PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Heating Water Pipe and Fittings.
   2. Drain Pipe and Fittings.

B. Related Sections:
   1. 15060 Hangers and Supports.
   2. 15080 Mechanical Insulation.

1.2 REFERENCE

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

C. American Water Works Association (AWWA)

D. International Association of Plumbing & Mechanical Officials (IAPMO)

E. National Sanitation Foundation (NSF)

PART 2 - PRODUCTS

2.1 HEATING WATER PIPE

A. Copper: Type “L” hard, conforming to ASTM B-88.
   1. Wrought copper or cast brass solder fittings conforming to ANSI B16.22.
   2. Wrought copper or cast brass “press-fit” fitting for above grade conforming to ANSI B16.22.
   3. Wrought copper or cast brass grooved fittings for mechanical joints conforming to ANSI B16.22 and ANSI B16.18 with copper tubing sized grooved ends. EPDM gaskets for temperatures to 230°F and working pressure to 150 PSI.
      a. Rigid couplings; 2” to 8”; angled pad design for rigidity.
      b. Rigid couplings; 2’ to 8”; installation ready stab-on design for installation without prior field disassembly, and no loose parts; housing cast with offsetting angle-patter bolt pads.

B. Steel: Standard weight, Schedule 40 conforming to ASTM A-53.
   1. Cast iron screwed fittings 2” diameter and smaller, and malleable iron welding fittings 2½” diameter and larger. Provide flange fittings at valves, pumps and equipment. No threadolets, weldolets or welded stubs for branches off mains.
   2. Rolled grove ends; ductile iron rolled groove fittings; mechanical couplings, mechanical side outlet couplings, and hole cut branch tap fittings; with EPDM gaskets for

temperatures to 230°F and working pressure to 150 PSI. Provide flange fittings at valves, pumps and equipment.

2.2 DRAIN PIPE

A. Backflow Preventer Relief Ports:
   1. Schedule 40 PVC with solvent weld joints.
   2. Copper type “L” hard with wrought copper or cast brass solder fittings.

B. Pressure/Temperature Relief Valve Discharge
   1. Copper type “L” hard with wrought copper or cast brass solder fittings.

PART 3 - EXECUTION

3.1 HEATING PIPE

A. Provide for movement due to expansion. Anchor pipes securely when required for distributing expansion stresses. Swing joints at all supply and return take offs from main lines.

B. Measure and cute to actual building conditions, install parallel perpendicular to walls, beams, etc. Install without forcing or springing riser plumb.

C. Clearance from other pipe or obstacles and within sleeves adequate to permit insulation maintenance.

D. Pitch: Water piping up 1” per 40’ in direction of flow; Down feed branches off bottom side of main, pitched down ½” per foot; Up fee branches off top side of main, pitched up ½” per foot. Drain valves at low points to drain system.

E. Valves and piping installed adjacent to pumps, coils, chiller, boilers, etc., same as line size unless sized for pressure drop.

F. Copper solder fittings: Piping reamed, polished and joined with 95-5 lead-tin solder. No self-cleaning flux.

G. Copper “press-fit” fittings: Piping square cut, deburred and cleaned. Fitting manufacturer’s gauge used to ensure full insertion into the coupling or fitting. Fitting manufacturer’s tool used for pressing.

H. Threaded fittings: Full, clean threads. Joints made with an approved oil-graphite compound applied to male thread.

I. Solvent weld fittings: Piping square cut, deburred, cleaned and marked for full insertion into couplings or fittings. Joint compound applied to pipe and fitting prior to insertion in accordance with manufacturer’s directions.

J. PEX piping may be used within equipment enclosures and for radiant panels connections only. Piping for radiant panels shall be limited to panel connections only not new distribution mains.

K. Test line to 100 PSI hydrostatic with no visual leaks or abnormal pressure loss. Provide a certificate of acceptance, signed by the Owner’s Representative, to be incorporated in the Operation and Maintenance Manual.

3.2 DRAIN PIPE

A. Slope down ¼" per foot, route to floor drain and anchor.

B. Trap of 3" water seal depth minimum with vent.

3.3 ELECTIRCAL EQUIPMENT CLEARANCE

A. No piping shall be installed directly above electrical switchboards or panelboards nor within dedicated clearance spaces required by the National Electrical Code. Coordinate with Electrical Contractor.

3.4 HYDRONIC SYSTEM RESTORATION

A. Provide and install a closed loop chemical treatment for all closed loop hydronic systems installed or modified. Program shall be implemented by factory trained chemical specialist. Send sample to manufacturer for analysis verifying inhibitor effectiveness and instruct Owner in procedures for periodic analysis. Incorporate tests in Brochure of Equipment.

END OF SECTION 15100

SECTION 15110 - MANUAL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Inline valves for manual shut-off, service isolation, basic flow control and drainage.

PART 2 - PRODUCTS

2.1 WATER SERVICE

A. Manufacturer: As scheduled. Equivalent Apollo, Boss, Crane, Grinnell, Jenkins, Hammond, Legend, McDonald, Milwaukee, Nibco, Stockman, Walworth, Worcester acceptable. All valves of each type of one manufacture, with manufacturer's identification tag on handle.

B. Requirements:
1. Ball Valves: Valves shall be rated 150 psi SWP and 600 psi non-shock WOG. Construction: Two-piece cast bronze body, TFE seats, separate packnut with adjustable stem packing, anti-blowout stems and stainless-steel balls. The valves to be manufactured to MSS-SP110 standards. Provide 2” extended non-thermal conductive handles for all insulated valves. Full port valves through 1” and conventional port 1-1/4” and larger. Sizes ½” –3”.
2. Globe Valves: Valves shall be Class 150 union bonnet. Manufactured in accordance with MSS-SP80. Construction: Bronze body and bonnet equal to ASTM B-62. Stems shall be dezincification-resistant silicone bronze ASTM B-371 or low zinc alloy B-99, non-asbestos packing TFE seat disc and malleable or ductile iron handwheel.
3. Check Valves: Valves shall be Class 125.
   a. Size 2-1/2” or Smaller
      Construction: ASTM B-62 bronze body with TFE seat disc.
      Y-pattern swing type manufactured in accordance with MSS-SP80.
   b. Size 3” and Larger.
      Swing type manufactured in accordance with MSS-SP71.
      Valve Construction: Flanged ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket or wafer style with stainless steel spring, bronze disc plates, rubber seat, body of ASTM A 126 Class B.
   c. Lift Checks.
      Spring-actuated for immediate closure.
      Valve Construction: Cast iron ASTM-A126 body, bronze seat and disc ASTM B584, Type 316 stainless steel spring, stop pin and hinge.
4. Drain Valves: Valves to be rated to 200 psig non-shock cold water working pressure.
5. Construction: Forged brass body, aluminum handle, coated steel handle nut and Teflon seat. Ball design with ¾” hose end. Provide service cap for hose end.

C. Heating Water

Valve	Mfg.	½" - 2"	2½" - 3"	4" - 12"
Ball	Nibco	585-70-66	585-70-66	--
Globe	Nibco	235-Y	F718-B	F760-B
Check	Nibco	433-Y	433-Y	F-918-B
Drain	Nibco	107-168	--	--

2.2 DOMESTIC WATER BALANCING VALVES

A. For Balancing and Measuring Valves:
1. Product of Taco. Equivalent Armstrong, and Bell and Gossett.
2. Model Accu-Flo, circuit setter. The valve shall be a combination service shut-off, balancing and flow measurement device. The materials of construction shall be blow-out proof, sealed with an EPDM O-ring. The flow measurement shall be accomplished by means of a fixed geometry venture style sensor of corrosion resistant materials. Pressure reading ports shall be Schrader style connection. The valve shall be a double seated ball style, and the seat shall be Teflon and designed for shut-off service. The memory stop shall be robust design capable of flowing return of the stem/ball to originally set position after use as a servicing shut-off valve. The balancing valve stem shall have wrenching flats for normal setting. The valve stem all be capable of operation by a 4:1 turn ratio for stem positioning. The valve may have a plugged drain connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Application: Ball, gate and butterfly valves for use as shut-off; globe and butterfly for throttling duty.
1. Locate all valves for maximum service access to handle for operation and that the valve in turn can be removed for servicing without removing any other piping or equipment.
2. Locate all valves to allow valve position indication to be read while standing at floor level.
3. Install valves in horizontal piping with stem at or above the center of the pipe.
4. Install valves in position to allow full stem movement.
5. Tests: After piping systems have been tested and put into service, inspect valves for leaks prior to final balancing. Adjust or replace packing if required. If leaks persist replace the valve prior to final balancing.

3.2 REMOVAL PROVISIONS

A. Install screwed and soldered valves with union connections at one end for equipment removal. Flanged devices do not require removal provisions.

3.3 DIELECTRIC PROVISIONS

A. Provide dielectric unions or dielectric gaskets for all valves and piping of dissimilar materials.

3.4 THREADED CONNECTIONS

A. Apply appropriate tape and or thread compound to the mail pipe threads.

END OF SECTION 15110

SECTION 15115 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Pressure Reducing Stations.
2. Backflow Preventers.

1.2 SUBMITTALS

A. Product Data: Manufacturer’s literature, installation instructions and maintenance requirements.

PART 2 - PRODUCTS

2.1 PRESSURE REDUCING STATION

A. Product of Watts. Equivalent Fisher acceptable. Model 223, size ½”-1-1/2”. 75 PSI in, 12 PSI out. Bronze body, stainless steel components, complete with strainer and unions.

2.2 BACKFLOW PREVENTERS

A. Product of Watts. Equivalents acceptable

B. Hydronic Water Make-up Systems: Model 909-S-909AG series, ¾”-2”, unit complete with primary and secondary check valves, vent port, bronze strainer, AG series air gap drain size outlet

PART 3 - EXECUTION

3.1 GENERAL

A. All valves shall be located for maximum service access for operation and maintenance.

3.2 PRESSURE REDUCING STATION

A. Adjust PRV for satisfactory system pressure at design flow.

3.3 BACKFLOW PREVENTER

A. Complete assembly including shut-off valves shall be located horizontal position as listed by manufacturer. Route drain line from relief connection to nearest approved receptacle.

3.4 CONTROL VALVE INSTALLATION

A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.

B. All control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position.

C. Valves shall be installed in accordance with the manufacturer's recommendations.

D. Control valves shall be installed so that they are accessible and serviceable, and such that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.

E. Isolation valves shall be installed such that control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screwed type control valves.

F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1-1/2" in diameter, with 1/4" high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

END OF SECTION 15115

SECTION 15120 - PIPE SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Unions and Reducers.
2. Escutcheons.
3. Strainers.
4. Thermometers.
5. Gauges.

B. Related Section: 15100 – Pipe and Fittings

PART 2 - PRODUCTS

2.1 UNIONS AND REDUCERS

A. Unions and reducers as required having the same gauge and material as the pipe.

B. Dielectric Unions: Rated at 250 psig at 180℉ conforming to ANSI B16.39. Factory certified to withstand a minimum of 600 volts on a dry line with no flash over. All pipe threads are in accordance with ANSI B2.1.

2.2 ESCUTCHEONS

A. Split ring, chrome plated, concealed hinges, tension clamp.

B. Sure grip flanges, chrome plated, shallow, deep or box type as required.

2.3 STRAINERS

A. PRODUCT OF Sarco or Equal

B. Construction: cast bronze body ASTM B62 with external rib, tapered screen socket, stainless steel, 1.045 perforated screen, blow-down plug and sediment collection chamber below screen. Sizes ½” to 3”. For sizes 4” and larger use Sarco model AF-250 flanged strainer or equal.

2.4 THERMOMETERS

A. Product of Trerice or equivalent. Model BX, adjustable mount, 9’ enclosed window case, with range as follows:

1.	Domestic	30°F to 150°F
2.	Heating Water	30°F to 240°F

2.5 GUAGES

A. Pressure: Product of Trerice or Equivalent. Model 800 brass gauges, 2-1/2" dial, with range as follows:

1.	Domestic	0 to 100 psi
2.	Heating Water	0 to 60 psi

PART 3 - EXECUTION

3.1 UNIONS AND REDUCERS

A. Install unions where shown on the drawings and where required for proper maintenance to remove equipment, valves, pipe sections, etc. Unions must be installed only in accessible locations.

3.2 ESCUTCHEONS

A. Install escutcheons in all finished areas including under cabinets. Use deep flange type to conceal PVC to metal coupling nuts and piping sleeves through walls.

3.3 STRAINERS

A. Install all fittings with union connections at one-end for equipment removal. Flanged units do not require unions. Provide blow-down valve for all units 2" and larger. Pipe blowdown to available floor drain or accessible point if acceptable to maintenance staff.

3.4 THERMOMETERS

A. Provide well in tanks and piping. Install at height and angle for viewing from standing position on the floor.

3.5 GAUGES

A. Pressure: Provide gauge tees in piping. Install shut-off valves and siphon tubes in gauges lines for gauge service.

3.6 GENERAL

A. Mount all specialties for adequate access and removal room.

END OF SECTION 15120

SECTION 15130 - PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide circulating pumps as scheduled.

B. Related Section: 15180 – Heating and Cooling Piping Specialties

1.2 SUBMITTALS

A. Product Data: Manufacturer’s literature, installation instructions, maintenance requirements and wiring diagrams.

B. Shop Drawings:
1. Manufacturer’s standard dimensional drawings.
2. Performance curves clearly marked with specified operating point(s). curves to include multiple rpm ranges and hp curves.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Equivalent products of Armstrong, Bell & Gossett and Taco acceptable.

2.2 GENERAL REQUIREMENTS

A. Domestic Water – All bronze construction. Flexible coupling, flanged, centrifugal impeller, oil lubricated bearings, 225° F, continuous operating seals.

B. Low Temperature Heating Water – Bronze fitted cast iron for heating pumps. Flexible coupling, flanged, centrifugal impeller, oil lubricated bearings, 225°F, continuous operating seals.

C. Provide nameplate stamped with motor characteristics, impeller size and design performance characteristic.

2.3 VARIABE SPEED WET ROTOR CIRCULATOR PUMPS

A. Pump shall be of the in-line wet rotor design. Oil lubricated pumps and shaft coupled pumps shall not be accepted.

B. The pump shall be a standard product of a single pump manufacturer. The pump, motor, and variable speed drive shall be an integral product designed and built by the same manufacturer.

C. The enclosure shall be marked “Enclosure Type 2.”

D. The pump shall be certified and listed by a Nationally Recognized Test Laboratory (NRTL) for U.S. and Canada to comply with:
1. UL778
2. UL 60730-1A
3. CAN/CSA No. 108

E. The pump shall be labeled on the nameplate as having an Energy Efficiency Index (EEI) of no greater than 0.20.

F. Ratings

1.	Maximum Pressure:	175 PSIG
2.	Minimum Media Temperature:	14° F
3.	Maximum Media Temperature:	230° F
4.	Maximum Continuous Media Temperature:	203° F
5.	Maximum Sound Pressure Level:	43dB(A)
6.	Voltage:	1x115V+/-10% or 1x208-203V+/-10%
7.	Maximum Energy Efficiency Index:	0.20

G. Pump Construction
1. Pump housing: Cast iron: EN-JGL-250 with Cataphorese surface treatment.
2. Impellers: Composite PES 30% GF.
3. Rotor Can: PPS reinforced with Carbon Fiber (Fortran MT9141L PPS-GF40)
4. Rotor Cladding: 316 Stainless Steel.
5. Stator Housing: Aluminum
6. Shaft: 316L Stainless Steel
7. Thrust Bearing: Axial: Carbon Graphite, Radial: ceramic Alumina Hilox 961.
8. O-Rings: EPDM
9. Bearing Plate: 304 Stainless Steel
10. Neck Ring: 304 Stainless Steel
11. Control Box: Polycarbonate

H. Motor
1. Motor shall be 4-pole permanent-magnet (PM motor) and tested with the pump as one unit by the same manufacturer. Conventional asynchronous squirrel-cate motors shall not be accepted.
2. Each motor shall be of the integrated Variable Speed Drive design consisting of a motor and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.
3. The stator housing shall be made of pressure die cast aluminum.
4. The motor shall be cooled by the pumped fluid.
5. The power electronics shall be cooled by the ambient air.
6. The Motor shall be self-ventilating.
7. Minimum insulation class for the motor shall be Class F.
8. The integrated VFD control shall utilize an energy optimization algorithm to minimize energy consumption by reducing the factory-set setpoint and adjusting to system characteristics. This shall be accomplished without the need for any external sensors or input.

I. Operating Modes: The pump shall have the following control mode and operating modes:
1. AUTOADAPT – During operation the pump automatically reduces the factory-set setpoint and adjusts it to the actual system characteristic. Manual setting of the setpoint is not possible.
2. FLOWLIMIT – It shall be possible for the user to select a maximum flow that the pump shall not exceed in order to eliminate the need for additional throttling valves. The pump shall operate per selected control mode by will limit speed to not exceed the user specified flow limit.

3. FLOWADAPT – The pump shall operate in the AUTOADAPT control mode with FLOWLIMIT enabled.
4. Proportional Pressure – The head delivered shall be reduced from a manual setpoint linearly in accordance with decrease in flow demand in the system.
5. Constant Pressure – A manual set, constant head is maintained, regardless of flow up to the maximum speed of the pump.
6. Constant Curve – The pump runs as an uncontrolled pump by the means of a set of pump curves. The pump curve is adjustable between maximum and minimum from the control panel or through a wireless remote control.
7. Constant Temperature – The pump shall adjust speed to maintain a constant media temperature in the flow pipe in which the pump is installed.
8. Constant Differential Temperature – The pump shall adjust speed to maintain a constant temperature drop between the flow pipe in which the pump is installed, and a user installed temperature sensor.
9. Alternating Operation – Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. In alternating operation, only one pump shall operate at a time. The operation shall alternate based on time or energy to ensure even run time of both pumps. If a pump stops due to fault the other pump shall take over automatically.
10. Back-Up Operation – Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. In Back-Up operation one pump shall operate continuously. If the duty pump stops due to fault, the back-up pump shall take over automatically.
11. Cascade Operation – Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. Tow pumps shall operate together in constant pressure control. The pump controller shall determine when to operate a single pump or both pumps to meet demands. While bother pumps operate, they shall run at the same speed.

J. Interface and Communication
   1. The pump shall have an integrated operator interface consisting of:
      a. Minimum 2.4” (measured diagonally) color TFT display.
      b. 7 push buttons for navigation of menu.
      c. Push buttons must be able to operate at minimum 25,000 times.
      d. Push buttons must be isolated from the main supply by reinforced insulation according to UL60730.
      e. LEDs to signal pumps status for quick indication.
   2. The pump shall have a sensor integrated directly into the pump housing with 4 lines consisting of Ground, Supply, and two signals for Differential Pressure and Media Temperature.
      a. Sensor Supply shall be 4.8V DC+/-2% at 20mA reference to Ground. The supply must be able to withstand a permanent short circuit.
      b. The electrical values for the signal shall be 4.8V DC+/-2% referenced to ground.
   3. The pump module shall have one analog input configurable for either 4-20mA or 0-10V DC input signal configurable for external Temperature or Pressure sensor, or Setpoint influence. Sensor input shall have three wires for Ground, Supply and Signal. The Supply for external analog input shall be 24V DC+/- 10% at 22mA reference to Ground. The supply must be able to withstand a permanent short circuit. Connection can be made to a screw terminal capable of wire sizes up to AWG16.
   4. The pump shall have 3 Digital inputs galvanically isolated from the main supply by a reinforced insulation according to UL 60730.
      a. Start/Stop – Used to start or stop the pump. The pump shall be enabled when connected to common ground by an external potential free short circuit. An open circuit to this input shall disable the pump. Connection can be made to a screw terminal capable of wire sizes up to AWG16.

b. Minimum – used to force the pump to run at minimum load (curve.) When connected to common ground by an external potential free short circuit the pump must run at a minimum load. Connection can be made to a screw terminal capable of wire sizes up to AWG16.
c. Maximum – used to force the pump to run at maximum load (curve.) When connected to common ground by an external potential free short circuit the pump must run at maximum load. Connection can be made to a screw terminal capable of wire sizes up to AWG16.

5. The pump module shall have town Output Relays. Each relay shall be configurable for Alarm, Reading or Operating indication. Each relay must have three screw terminals – see above. Output relays contacts shall be rated for maximum 250V AC and @a and minimum 5V DC at 20mA. Each must have galvanic isolation from the internal supply by reinforced insulation according to UL60730.
6. Shall be capable of accepting an optional add-on module for integration in Building Management Systems:
   a. LonWorks
   b. Bacnet
   c. Modbus
   d. Profibus
7. The pump module shall have wireless connectivity for two pumps to communicate with one another or for the pump to communicate to a mobile device with additional hardware.
   a. Communication range minimum shall be within 30 ft. of the pump without walls or barriers.
   b. Two identical pumps shall be capable of wireless communication with one another to operate as a two-pump system in:
      1) Duty/Standby.
      2) Alternating Mode - pumps alternate operation every 24 hours.
      3) Cascade operation with both pumps running simultaneously in constant differential pressure mode.
8. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture. Warranty shall cover pump, motor and terminal box as a complete unit.

2.4 VERTICAL IN-LINE MULTI-STAGE VARIABLE SPEED PUMP

A. All pumps shall be ANSI/NSF 61 Annex G Listed for drinking water and low lead requirements.

B. The pumps shall be of the in-line vertical multi-stage design.

C. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

D. Small Vertical In-Line Multi-Stage Pumps (Nominal flow from 3 to 125 gallons per minute) shall have the following features:
   1. The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.
   2. The suction/discharge base shall have ANSI Class 250 flange or internal pipe thread (NPT0 connections as determined by the pump station manufacturer.
   3. Pump Construction:
      a. Suction/discharge base, pump head, motor stool: Cast iron (Class 30)
      b. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
      c. Shaft: 316 Stainless Steel
      d. Impeller wear rings: 304 Stainless Steel
      e. Shaft journals and chamber bearings: Silicon

f. O-Rings: EPDM

4. Shaft couplings for motor flange sizes 184 TC and smaller shall be made of cast iron or sintered steel. Shaft couplings for motor flange sizes larger than 184TC shall be made of ductile iron (ASTM-60-40-18.)
5. Optional materials for the suction/discharge base and pump head shall be cast 316 stainless steel (ASTM CF-8M) resulting in all wetted parts of stainless steel.
6. The shaft seal shall be a balanced O-Ring cartridge type with the following features:
   a. Collar, Driver, Spring: 316 Stainless Steel
   b. Shaft Sleeve, Glad Plate: 316 Stainless Steel
   c. Stationary Ring: Silicon Carbide
   d. Rotating Ring: silicon
   e. O-Rings: EPDM
   f. The Silicon Carbide shall be imbedded with graphite.
7. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft and coupling motor. The entire cartridge shaft seal shall be removable as a one-piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

E. Integrated Variable frequency Drive Motors
1. Each motor shall be of the Integrated Variable Frequency Drive design consisting of a motor and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.
2. The VFD shall be of the PWM (Pulse Width Modulation) design using current IGBT (Insulated Gate Bipolar Transistor) technology.
3. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.
4. The VFD shall utilize an energy optimization algorithm to minimize energy consumption. The output voltage shall be adjusted in response to the load, independent of speed.
5. The VFD shall automatically reduce the switching frequency and/or the output voltage and frequency to the motor during periods of sustained ambient temperatures that are higher than the normal operating range. The switching frequency shall be reduced before motor speed is reduced.
6. An integral RFI filter shall be standard in the VFD.
7. The VFD shall have a minimum of two skip frequency bands which can be field adjustable.
8. The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
9. The integrated VFD motor shall include protection against input transients, phase imbalance, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. Three-phase integrated VFD motors shall be capable of providing full output voltage and frequency with a voltage imbalance of up to 10%.
10. Integrated VFD motor shall have as a minimum, the following input/output capabilities:
    a. Speed Reference Signal: 0-10 VDC
    b. Digital remote on/off
    c. Fault Signal Relay (NC or NO)
    d. Fieldbus communication port (RS485)
11. The motor shall be Totally Enclosed Fan Cooled (TEFC) with a standard (NEMA C-Face, Class F insulation with a temperature rise no higher than Class B.
12. The cooling design of the motor and VFD shall be such that a Class B motor temperature rise is not exceeded at full rated load and speed at a minimum switching frequency of 9.0 kHz.

13. Motor drive and bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

F. WARRANTY
1. The warranty period shall be a con-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture.

PART 3 - EXECUTION

3.1 GENERAL

A. Connect gauge tappings with common tubing and gauge tee with ball valves inline to inlet and outlet of pump housing.

B. Align the pump housing with piping before piping is bolted to housing. **DO NOT USE** pump housing to force piping into line. Align motor and pump shafts.

3.2 IN-LINE PUMPS

A. Suspend bearing assembly with rod and rubber vibration isolator. Install per manufacturer instructions.

B. Provide straight length of section piping five (5) times the pipe diameter to prevent unequal impeller loading.

END OF SECTION 15130

SECTION 15180 – HEATING AND COOLING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Air Control Devices.
   2. Balancing Fittings.

1.2 SUBMITTALS

A. Product Data: Manufacturer's literature, installation instructions, maintenance requirements and wiring diagrams.

PART 2 - PRODUCTS

2.1 AIR CONTROL DEVICES

A. Equivalent products of Bell & Gossett, Armstrong, Amtrol, Spirovent, Caleffi, Taco, Wessels and Wheatley acceptable.

B. Air Vents: B&G #4V coin operated for radiation. B&G #107A automatic with cap for mains within mechanical rooms. Dole #14, key operated with tubing for above finished ceilings B&G #107A automatic pilot operated high capacity vent air purger.

2.2 BALANCING FITTINGS

A. For Balancing and Measuring Valves:
   1. Product of Taco. Equivalent Armstrong, and Bell and Gossett.
   2. Model Accu-Flo, circuit setter. The valve shall be a combination service shut-off, balancing and flow measurement device. The materials of construction shall be blow-out proof, sealed with an EPDM O-ring. The flow measurement shall be accomplished by means of a fixed geometry venture style sensor of corrosion resistant materials. Pressure reading ports shall be Schrader style connection. The valve shall be a double seated ball style, and the seat shall be Teflon and designed for shut-off service. The memory stop shall be robust design capable of flowing return of the stem/ball to originally set position after use as a servicing shut-off valve. The balancing valve stem shall have wrenching flats for normal setting. The valve stem shall be capable of operation by a 4:1 turn ration for stem positioning. The valve may have a plugged drain connection.

PART 3 - EXECUTION

3.1 AIR CONTROL DEVICES

A. Locate air vents on all up-fed units, and any high point which may form an air trap. Locate shutoff valve below automatic air vents. Indicate all valves as As-Built Drawings.

3.2 BALANCING VALVES

A. Provide independent isolation valves with every balancing valve.

B. Install valves as directed from piping fittings, accessories, equipment, etc.

3.3 GENERAL

A. Mount all specialties for adequate access and removal room.

END OF SECTION 15180

SECTION 15510 - BOILERS

PART 1 - GENERAL

1.1 GENERAL

A. Section includes high efficiency, gas-fired, horizontal, compact copper fin boilers.

1.2 REFERENCES

A. ASME Boiler and Pressure Vessel Code, Section IV – Heating Boilers.

B. NFPA 54 – National Fuel Gas Code.

C. ASHRAE 90.1 – Standard for Energy Efficiency in New Buildings.

1.3 SUBMITTALS

A. Product Data: Manufacturer’s literature, installation instructions and maintenance requirements.

B. Shop Drawings: Factory fire test report.

C. Closeout Submittals: Field startup and fire test report.

1.4 SYSTEM DESCRIPITION

A. Performance Requirements
   1. Horizontal copper fin boilers shall have nominal efficiency of 94% minimum.

1.5 QUALITY ASSURANCE

A. Boilers shall conform to all ASME, AGS, UL FM and IMC standards as applicable.

B. Packaged boilers shall be fully assembled, and factory fire tested with test reported and submitted for review and inclusion in the Brochure of Equipment.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturer: Boilers shall be product of Lochinvar Corporation or Patterson Kelley. Equivalent products acceptable with prior approval. Applicable choices are detailed here; however, project boilers shall be of only one manufacturer.

B. Capacity and size as indicated on schedule on Drawings.

2.2 LOCHINVAR BOILERS

A. Manufacturer: Boilers shall be Lochinvar FTXL Model FTX 600 (N) having a modulating input rating of 600 Btu/Hr, an output of 585 Btu/Hr and shall be operated on natural gas. The boiler shall be capable of the following performance:
1. Turndown: 10:1
2. Minimum Input: 60,000
3. Maximum Input: 600,000

B. The boiler shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The boiler shall have a fully welded, stainless steel, fire tube heat exchanger. Multiple pressure vessels in a single enclosure are not acceptable. There shall be no banding material, bolts, gaskets or “O” rings in the pressure vessel construction. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 2.2 psi at 75 GPM. The condensate collection basin shall be constructed of welded stainless steel. The complete heat exchanger assembly shall carry a ten (10) year limited warranty.

C. The boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The boiler shall comply with the energy efficiency requirements of the latest edition of ASRAE 90.1 and the minimum efficiency requirements of the latest edition of the AHRI BTS-2000 Standard as defined by the Department of Energy in 10 CFR Part 431. The boiler shall operate at a minimum of 97% Combustion and Thermal Efficiency at full fire as registered with AHRI. The boiler shall be certified for indoor installation.

D. The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided for observing the burner flame and combustion chamber. The burner shall be a premix design constructed of high temperature stainless steel with a woven Ferroalloy outer covering to provide smooth operation at all modulating firing rates. The boiler shall be supplied with a negative pressure regulation gas valve and be equipped with a pulse width modulation blower system to precisely control the fuel/air mixture to the burner. The boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

E. The boiler shall utilize a 24 VAC control circuit and components. The control system shall have a factory installed display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The boiler shall be equipped with a temperature/pressure gauge; high limit temperature control and manual reset; ASME certified pressure relief valve set for 50 psi (standard); outlet water temperature sensor with a dual thermistor to verify accuracy; system supply water temperature sensor; outdoor air sensor, flue temperature sensor with dual thermistor to verify accuracy; low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.’

F. The boiler shall feature the “SMART SYSTEM™” control which is standard, and factory installed with 128 x 128 resolution display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities, USB drive for simple uploading of parameters and a PC port connection for connection to a local computer for programming and trending. A secondary operating control that is field mounted outside or inside the appliance is not acceptable. The boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The boiler shall have built-in “Cascade” with leader

redundancy to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal “Cascade” function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The boiler shall be capable of remote communication via optional CON-X-US™ Remote Connectivity with the capability of historical trending and sending text message or email alerts to notify the caretaker of a boiler alarm and remote programming of onboard boiler control. The boiler shall be capable of controlling an isolation valve (offered by manufacturer) during heating operation and rotation of open valves in standby operation for full flow applications. The control must have optional capability to communicate via Modbus protocol with a minimum of 46 readable points. The boiler shall have an optional gateway device which will allow integration with LON or BacNet protocols.

G. The “SMART SYSTEM™” control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0-10 VDC output signal shall control a variable speed boiler pump (offered by manufacturer) to keep a fixed Delta T across the boiler regardless of the modulation rate. The boiler shall have the capability to receive a 0-1 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues such as erratic temperature cycling.

H. The boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 46 connection points for safety and operating controls, i.e., Alarm contacts, Runtime Contacts, Louver Proving Switch, Tank Thermostat, Domestic Hot Water Building Recirculation Pump Contacts, Domestic Hot Water Building Recirculation Temperature Sensor Contacts, Remote Enable/Disable, System Supply Temperature Sensor, Outdoor Temperature Sensor, Tank Temperature Sensor, Modbus Building Management System Signal and Cascade Control Circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt/ 60 hertz/ single phase on all models. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump.

I. The boiler shall be installed and vented with Direct Vent system with horizontal sidewall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved material constructed of PVC, CPVC, Polypropylene or Stainless Steel. A separate pipe shall supply combustion air directly to the boiler from the outside. The boiler’s total combined air intake length shall not exceed 100 equivalent feet. The boiler’s total combined exhaust venting length shall not exceed 100 equivalent feet.

J. The boiler shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments. The boiler shall be certified for operation at elevations of 4,500 feet and above, by a 3rd party organization.

K. The boiler shall be suitable for use with polypropylene glycol up to a 50% concentration. The de-rate associated with the glycol will vary per glycol manufacturer.

L. **Note: Due to the large disparity in CSD-1 interpretation form state to state, please confirm to the factory all controls required in your jurisdiction.**

PART 3 - EXECUTION

3.1 INSTALLATION

A. Position for adequate access and level units. Remotely mount system control panel, system low-water cut-off, system sensors, etc.

B. Pipe boilers to allow for pipe expansion.

C. Pipe relief valve discharge to nearest floor drain.

D. Connect venting and combustion air piping in accord with recommendations.

E. Interconnection piping is the responsibility of the Mechanical Contractor. Most of this wiring is covered by 15900 yet any additional wiring shall be the responsibility of the mechanical contractor to have completed by a contractor of his choice.

3.2 TESTING

A. Unit(s) shall be field fired and checked by factory trained service technician experienced in the complete operation of system in conjunction with Control Contractor. See Section 15900 – Energy Management and Control System for control wiring.

B. Field firing tests shall be conducted with each boiler operating throughout the range of anticipated operation conditions. If weather conditions do not permit complete testing on initial start-up a follow-up test shall be scheduled when heating demand can be observed.

C. Start-up and check-out reports shall be included in the Brochure of Equipment.

END OF SECTION 15035

SECTION 15550 – FLUE AND BREECHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Venting systems for fuel fired heating equipment.
   2. Combustion air ducting for separated combustion equipment.

B. Related Section: 15510 Boilers

1.2 REFERENCES

A. National Fire Protection Association (NFPA): NFPA 54 – National Fuel Gas Code.

B. Underwriters Laboratories (UL):
   1. UL 441: Standard for Gas Vents.
   2. UL 1738: Standard for Venting Systems for Gas Burning Appliances, Categories II, III and IV.

1.3 SUBMITTALS

A. Product Data: Manufacturer’s literature, installation instructions and maintenance requirements.

B. Shop Drawings: Provide manufacturer’s assembly drawings for the actual configuration of manufactured chimney systems to be furnished for this project.

PART 2 - PRODUCTS

2.1 PVC VENT AND COMBUSTION AIR PIPE

A. Schedule 40 PVC piping with solvent weld joints

B. Manufactures roof or wall termination kit.

PART 3 - EXECUTION

3.1 GENERAL

A. All breeching and flues gas tight; all joints in strict accord with manufacturer’s recommendations and gas codes.

B. Venting system should be arranged for draining back to equipment, or else drains should be provided at low points.

C. Vent terminations 3 fee minimum above roof, and 2 feet minimum above adjacent structures within 8 feet.

D. All components installed to maintain clearances to combustibles as required by code and product listings.

E. Boiler vent sizing shall be verified by boiler manufacturer prior to ordering material.

3.2 PVC Vent

A. Install trap leg at equipment vent connection and provide a condensate drain with inline trap routed from the trap leg to a floor drain.

B. Support horizontal pipes at maximum 6 ft intervals.

3.3 BREECHING

A. Support breeching at 6 ft. intervals with steel strap to structure. Install lapping slip joints with the inside pipe being the upstream section.

3.4 MANUFACTURED VENTS AND CHIMNEYS

A. Supports and clearance to combustibles shall be in complete accord with manufacturer's instructions.

3.5 SCHEDULE

EQUIPMENT	*BREECHING*	*VENT*	*COMB AIR*
High Efficiency Boilers*	N/A	Type 1	Type 1

*Non-metallic venting material approved by manufacturer for application are acceptable.

END OF SECTION 15550

SECTION 15810 – DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide ductwork for movement of air as indicated by the requirements of this section.

1.2 CODES AND STANDARDS

A. Duct construction shall be in conformance with the requirements of the International Mechanical Code and SMACNA Duct Construction Manuals.

1.3 SUBMITTALS

A. Provide Product Data and Shop Drawings including layout type floor plan drawings (1/8” scale) of pre-manufactured ductwork, complete including elbows, fittings, transitions, etc.

PART 2 - PRODUCTS

2.1 REQUIREMENTS

A. All systems shall conform to SMACNA requirements for B seal class minimum and the pressure class as scheduled, except where plans designate an allowable change to the next lower pressure class.

SYSTEM	***SUPPLY***	***RETURN***	***MIXED***	***OUTDOOR***	***RELIEF***
Air Handlers	2” Class A	2” Class A	2” Class A	2” Class A	2” Class B
Exhaust Fans		2” Class A			

2.2 GALVANIZED STEEL

A. Rectangular: In accord with SMACNA requirements for specified pressure classes including metal gauges; corresponding minimum seal classes; intermediate reinforcement spacing and rigidity classes; and longitudinal seams.

B. Circular, Fabricated: In accord with SMACNA requirements for specified pressure classes, including metal gauges; corresponding minimum seal classes; longitudinal seam classes or spiral seams; and transverse joints.

C. Pre-Manufactured: Equivalent products of Foremost, Norlock, Sheet Metal Connectors, Semco, United and Ventline acceptable. Zinc coated steel with grooved or welded seam spiral wound. Machine formed slip joint fittings with smooth transitions. Branch take-off fittings shall be conical 45-90-degree laterals or “lo-loss” tees unless specifically noted otherwise.

2.3 FIBERGLASS DUCT

A. Circular, Flexible: Equivalent products of Clevaflex, Flexmaster, Flexible Air movers, Genflex, Omni Air, Thermaflex and Wiremold acceptable. Minimum on (1) inch thick insulation, plastic vapor barrier, reinforced with spiral steel wire, fire rated per NFPA 90A requirements for UL 181 Class I Air Duct, for minimum working pressure as follows:
1. 1” WG positive, 1” WG negative – low velocity systems (Diffusers)

2.4 DUCT HANGERS AND SUPPORTS

A. Metal Duct up to 2” Pressure Class: Sheet metal strap type hanger. Double angle for vertical support.

B. Fiberglass, Flexible: Metal strap, minimum 4” wide under duct, with straps to structure.

2.5 DUCT SEALANT

A. Product of Ductmate. Equivalent Harcast acceptable. Model 795, semi-elastometric sealant, service temperature -20°F, 0/5 smoke density and flame spread rating, etc.

PART 3 - EXECUTION

3.1 GALVANIZED STEEL

A. Rectangular: Installed for specified pressure class and minimum leakage including sealed joints, corner closures, etc. Seal with fabric mesh and adhesive. Strap or trapeze hangers per SMACNA recommendations. Lock and drive seam construction with smooth inside surfaces, airtight slip joints in direction of flow. Duct sides 19” thru 60” and over with more than 10 sq.ft. and no internal insulation shall be stiffened by bead breaking.

B. Circular: Installed for specified pressure class and minimum leakage. Joints slip fitted tightly in direction of air flow. Seal with fabric mesh and adhesive. Exercise care to avoid dents or rough edges at joints that created noise and excess pressure loss. Strap or trapeze hangers per SMACNA recommendations for above grade.

3.2 FIBERGLASS

A. Circular, Flexible: Connections clamped with a mechanical fastener and wrapped with duct tape for an airtight seal. Stretch to full length, and trim to minimize excess material. Turns made with long radius bends where possible. Support above ceiling with four-inch-wide saddles suspended from structure at 4 ft. O.C. maximum.

3.3 DUCT HANGER AND SUPPORTS

A. Metal Duct up to 2” Pressure Class: Secure strap to duct with metal screws with two (2) suspensions to structure, spaced at intervals in strict accord with latest SMACNA recommendations.

B. Fiberglass, Flexible: Strap supports at 4’-0” O.C. maximum. Turns made with long radius bends where possible. Minimum radius equal to duct diameter.

3.4 GENERAL

A. Fittings, vanes, branches, offsets, transitions, and accessories in accord with SMACNA duct construction standard except as limited herein.

B. Sizes shown on drawings are internal finished clear sizes.

C. Size changes at 30 degrees maximum or as indicated.

D. Slope bottom of outside air and exhaust air ducts toward louvers. Seal bottom and sides of outside and exhaust ducts watertight.

E. Cap or seal all duct openings during construction.

F. Curves 1.5 radius, 90-degree elbows for all main and branch ducts less than 12”. Turning vanes in all main and branch 90-degree elbows 12” and larger.

G. Metal duct joints and seams exposed to weather shall be coated with fabric mesh and weather resistant sealing mastic.

H. Paint ductwork visible through louvers, registers, grilles, and diffusers flat black.

I. No ductwork shall be installed directly above electrical switchboards or panel boards nor within dedicated clearance spaces required by NEC. Coordinate with Electrical Contractor.

J. No ductwork shall be installed in elevator shafts or elevator equipment rooms except for the purpose of conditioning those spaces.

K. Provide access doors for ALL reheat coils and motorized dampers.

L. Seal all existing duct to the satisfaction of the Engineer prior to re-insulating system.

3.5 DUCT SEALANT

A. Install duct sealant with brush, putty knife, caulk gun and/or pump as directed by manufacturer.

B. Class A sealing requires all transverse joints, longitudinal seams, and duct wall penetrations.

C. Class B sealing requires all transverse joints and longitudinal seams.

END OF SECTION 15810

SECTION 15820 – DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flexible Fan Connectors
   2. Volume Control Dampers
   3. Turning Vanes
   4. Access Doors

B. Related Sections:
   1. Section 15810 – Ducts

1.2 SUBMITTALS

A. Product Data: Manufacturer's literature and installation instructions.

PART 2 - PRODUCTS

2.1 FLEXIBLE FAN CONNECTORS

A. Product of Duro-Dyne. Equivalents acceptable. Commercial grade neoprene coated fiberglass fabric with metal edges for all classes.

2.2 BRANCH DUCT VOLUME CONTROL DAMERS

A. Reinforced, 16 gauge minimum single and/or multiple opposed blade with Duro-Dyne, or equal, heavy duty 3/8" locking regulator, with wing nut in extended arm of regulator. Provide full length axles and quadrant activators.

2.3 TURNING VALVES

A. Equal Area 90° Elbows: Duro-Dyne, or equivalent. Curved vanes with 4 ½" radius, 2 ¼" spacing and/or 2" radius, 1 ½" spacing.

B. Unequal Area 90° Elbows: Field fabricated trailing edge type with maximum 2 ¼" spacing.

C. 30-89° Elbows: Field fabricated type, with trailing edges at unequal areas.

2.4 ACCESS DOORS

A. Rectangular Ducts: Cesco model HDD-10, or equal. Framed, hinged, camlock or handle type latch, gasketed double wall and internally insulated in insulated ducts. Size 12" x 12" minimum for inspecting, 24" x 24" minimum for service access unless duct requires a smaller size.

B. Fire and/or Smoke Dampers: Access doors shall be provided with a label with letters not less than ½" in height reading "Fire Damper," "Smoke Damper," or "Fire/Smoke Damper."

PART 3 - EXECUTION

3.1 FLEXIBLE FAN CONNECTORS

A. Install flexible fan connectors at all duct connections to air handling units, including exhaust fans, except equipment furnished with internal vibration isolation. Lap joint, sew and weld with sealing compound for airtight seal at duct connections. Staples are not permitted. Support unites and ductwork to prevent crimping of fabric and provide uniform spacing around duct.

3.2 BRANCH DUCT VOLUME CONTROL DAMPERS

A. Install at tees and branches, where flow division occurs, except in branches to volume control terminal units and flexible duct taps provided with "spur-in "dampers.

3.3 TURNING VANES

A. Install in all 30-90 deg. Rectangular mitered elbow 12" x 12" or larger. Curves elbows with continuous vanes parallel to radius may be used at Contractor's option. Provide curved elbows for smaller sizes and lesser angles.

3.4 ACCESS DOORS

A. Install at fire dampers, smoke dampers, reheat coils, (both upstream and downstream), duct mounted temperature control dampers, gravity backdraft dampers, duct mounted humidifiers, inlets to duct mounted fans, and where noted. Installation of fire damper access doors shall be in strict accordance with IMC regarding location, access, etc.

3.5 CONTROL DAMPER INSTALLATION

A. Damper submittals shall be coordinated or type, quantity and size to ensure compatibility with sheet metal design.

B. Duct opening shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼" larger than damper dimensions and shall be square, straight, and level.

C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimension must be equal ±1/8".

D. Follow manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.

E. Install extended shaft or jack shaft per manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)

F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to assure proper operation. On multiple section assemblies, all sections must open and close simultaneously.

G. Provide a visible accessible indication of damper position on the drive shaft end.

H. Support ductwork in area of damper when required to prevent sagging due to damper weight.

I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

J. Provide access door for visual verification of all motorized dampers. Minimum 12” x 12”.

END OF SECTION 15820

SECTION 15900 - ENERGY MANAGEMENT AND CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all engineering, labor, materials, and service necessary for a complete and operating temperature control system, utilizing a high-speed peer to peer network interoperable Direct Digital Controls (DDC), Graphical User Interface (GUI) with color graphics displays. System shall perform as shown on the drawings and as described herein. Project shall consist of the complete removal of the building pneumatic temperature control system.

1.2 SUBCONTRACTOR

All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work. The Control Contractor shall have an in-place support facility within 100 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system. In addition, the Control Contractor shall have 24 hours/day, 7 days/week emergency service available.

A. Approved manufacturer and factory/representative:
   1. ATS Inland NW, Billings, MT
   2. Additional sub-contractors may be permitted upon request. The Owner’s desire is to have a single Human Interface System. Replacement of existing components to achieve this function may be permitted.

1.3 RELATED WORK

A. All valves, dampers, motors, and equipment to be set in place by Plumbing and/or HVAC Contractor.

B. See Electrical drawings for building power furnished to control panels, controller locations, and lighting control panels.

C. Additional equipment and operating requirements are specified in the following Mechanical Sections:
   15940 Operating Sequences

D. Coordinate with Testing and Balancing Subcontractor:
   1. Assure fully operational conditions for testing.
   2. Provide simulations as required for Testing and Balancing in specified operating modes.
   3. See Section 15950 for systems to be tested.
   4. Complete system checkout sheets prior to pre-balance conference. Review of these sheets by the Engineer is required prior to scheduling the Pre-balance conference.

1.4 WARRANTY SERVICE

A. The entire system shall be warranted for a period of one year from the time the controls are accepted as substantially completed. For valves, controllers, etc., on individual equipment completed as part of phased construction the warranty will begin at the time of phase

substantial completion. All central control functions, networking and building management equipment will be from project substantial completion.

B. Provide for an interim functional check of systems. Functional checks shall correspond with Owner training and shall involve:
   1. Functional on startup of equipment due to seasonal weather.
   2. Operational status of systems.
   3. At the end of the warranty period, provide a complete functional check with a written report to the Owner and Engineer.

1.5 TRAINING

A. Provide 2 hours of on-site training of Owner personnel.

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials and installation and startup instructions for each type of product indicated.
   1. Each control device shall be labeled with setting or adjustable range of control.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
   3. Details of control panel faces, including controls, instruments, and labeling.
   4. Written description of sequence of operation.
   5. Schedule of dampers including size, leakage, and flow characteristics.
   6. Schedule of valves including close-off and flow characteristics.
   7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
   8. Listing of connected data points, including connected control unit and input device.
   9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
   10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems and interconnections.

C. ANSI/ASHRAE Standard 135-1995, BACnet PIC Statement: Proof of Compliance Level 3 or higher is required to protect Building Owner by reducing future maintenance and expansion costs.

D. Samples: For each color required, of each type of thermostat cover.

E. Software and Firmware Operational Documentation: Include the following:
   1. Engineering, Installation, Operation and Maintenance Manuals
   2. Program Software Backup: On magnetic media or a compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.
   5. Licenses guarantee and warranty documents for all equipment and systems.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Maintenance Data: For systems to include in maintenance manuals. Include the following:
1. Maintenance Instructions and list of spare parts for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

H. Project Record Documents: Record actual locations of control components, including control units, thermostats and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.7 OWNERSHIP AND PROPRIETARY MATERIAL

A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the Owner. These include, but are not limited to, project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

2.1

A. Equipment shall be all of one manufacture except only where unique functions, or requirements of controlled equipment furnished by others, necessitate use of particular components.

2.2 THERMOSTATS/SENSORS

A. General Sensor and Transmitter Requirements
1. Provide sensors and transmitters required as outlined in the input/output summary and sequence of operation, and as required to achieve the accuracy as specified herein.
2. Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.
3. Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearities of the sensor and bridge and shall provide a true linear output signal.
4. Temperature sensors shall be of the resistance type and shall be either three-wire 100-ohm platinum RTD, or two-wire 1000-ohm platinum RTD.
5. Thermistors are acceptable provided the mathematical relationship of a thermistor with respect to resistance and temperature with the thermistor fitting constraints is contained with the operating software, and the listed accuracies can be obtained. Submit proof of the software mathematical equation and thermistor manufacturer fitting constants used in the thermistor mathematical/expressions. Thermistors shall be of the Thermistor (NTC) Type with a minimum of 100 ohm/ F. resistance change versus temperature to ensure

good resolution and accuracy. Thermistors shall be certified to be stable ±0.24°F. over 5 years, and ±0.36°F. accurate and free from drift for 5 years.

6. The operating software shall be equipped with a self-calibrating feature for temperature sensors.
7. The following accuracies are required and include errors associated with the sensor, lead wire and A to D conversion.

Point Type	Accuracy
Outside Air	0.5° F.
Hot Water	0.75° F.
Duct Temperature	0.5° F.

B. Thermowells
1. When thermowells are required, the sensor and well shall be supplied as a complete assembly including well head and greenfield fitting.
2. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
3. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
4. Thermowells shall be constructed of the following materials:
   a. Hot Water; brass.

C. Outside Air Sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

D. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.

E. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

F. Averaging Duct Type Sensors
1. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, utilize an averaging sensor with multiple sensing points. The averaging sensor shall be a 304 stainless steel tube with holes extending across the duct or plenum to be sampled. A bleed hole outside the duct or plenum causes air to enter the sample tube and exit at the bleed hole, thus bathing the sensor in average air. The averaging sensor shall be installed complete with end cap, compression fittings, gaskets, mounting flange and required accessories.
2. Provide capillary supports at the sides of the duct to support the sensing string.

G. Differential Pressure Transmitters and Accessories
1. General Air and Water Pressure Transmitter Requirements:
   a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
   b. Pressure transmitters shall provide the option to transmit a 0 to 5V dc, 0 to 10V dc, or 4 to 20 mA output signal.
   c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (3 valve manifolds).
   d. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.
   e. Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize static pressure traverse probes.

H. Low Air Pressure Applications (0 to 0.5” WC)

1. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.
   a. Span: Not greater than two times the design space DP.
   b. Accuracy: Plus or minus 0.5% of F.S.
   c. Dead Band: Less than 0.3% of output.
   d. Repeatability: Within 0.2% of output.
   e. Linearity: Plus or minus 0.2% of span.
   f. Response: Less than one second for full span input.
   g. Temperature Stability: Less than 0.01% output shift per degree F change.
2. The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.

I. Static-Pressure Transmitter: Nondirectional sensor with suitable range for excepted input, and temperature compensated.
   1. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
   2. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
   3. Building Static-Pressure Range: -0.1 to 0.1; -0.25 to 0.25; -0.5 to 0.5; -1.0 to 1.0 in wc; jumper selectable.
   4. Duct Static-Pressure Range: 0 to 1.0; 0 to 2.5; 0 to 5.0; 0 to 10.0 in wc; jumper adjustable

J. Equipment operation sensors as follows:
   1. Status Inputs for fans: Differential-pressure switch with adjustable range of 0 to 5.0 in wc.
   2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
   3. Status Inputs for Electrical Motors: Current-sensing relay with current transformers, adjustable and set at 175 percent of rated motor current.

K. Water-Flow Switches: Pressure-flow switches of bellows actuated Mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless steel or bronze paddle. For chilled water applications, provide vapor proof type.

2.3 CONTROL PANELS

A. Manufacturer's standard enclosures for standalone controls.

B. Enclosed panel(s) with latching cover(s) sized for required control components not furnished in manufactured panels. Provide cover switches and gauges, neatly labeled with engraved plastic plates for easy identification, where external access to control functions is specified.

C. Provide wireway within control panels to manage all internal panel wiring. Wireway shall have removable cover to allow wiring alterations.

D. All wiring within control cabinets shall be labeled as to equipment served.

2.4 STANDALONE DDC PANELS

A. DDC panels shall be standalone, microprocessor based, multi-tasking, multi-user, real time digital control processors. Each panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules.

B. Stand-alone mode control functions operate regardless of network status. Functions include the following:

1. Automatic communications loss detection to maintain control functionality regardless of available network communications.
2. Discrete/digital, analog and pulse input/outputs.
3. Monitoring, controlling, or addressing data points.
4. Local energy management control strategies.
5. Incorporate internal customizable safeties and limits to prevent third party LonMark tools from providing improper and unrealistic inputs to the controller.

C. DDC panels shall provide at least two RS-232C serial data communication ports and one com net port, for simultaneous operation of multiple operator I/O devices such as industry standard printers, PC workstations, laptop workstations, and panel mounted or portable DDC panel Operator's Terminals. Panels shall allow normal operation of permanently connected modems, printers, or network terminals.

D. Communications: The controller shall communicate via the Primary Controller Network between controllers and other devices. The controller shall communicate at a baud rate of not less than 78.8K baud.

A. Product of Ruskin Model CD36 or equivalent.

B. Construction:
1. Frame: 5"x 1" x 16 gage galvanized steel hat channel reinforced with corner braces for structural strength equal to 13 gage. Low profile 3-1/2"x3/8"x16 gage galvanized steel channel top and bottom frame under 12" high.
2. Blades: Galvanized steel, 14 gage equivalent thickness, 6" wide. Blade extensions may be used on top and/or bottom to meet damper size requirements without diminishing the free area. Opposed blade action.
3. Linkage: Concealed into the frame.
4. Seals: Blade edge seals and flexible metal compression jamb seals. Temperature range -76°F to 350°F.

C. Dampers used for Smoke control shall meet UL Standard 555S, Class II at 250 deg. F. See Section 15825 for additional requirements.

D. Electronic Damper Actuators
1. General Requirements
   a. Electronic actuators shall be electric, direct coupled type capable of being mounted over the shaft of the damper. They shall be UL listed and the manufacturer shall provide a 2-year unconditional warranty from the date of commissioning. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts. Sound level shall not exceed 45 dB for high torque nor 35 dB for VAV actuators.
   b. Electronic overload protection shall protect actuator motor from damage. If damper jams actuator shall not burn-out. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.
2. Control Dampers Actuators
   a. All OA, RA and EXH actuators shall be spring return type for safety functions. Individual battery backup or capacitor return is not acceptable.
   b. The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within + or -1/21 of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are

paralleled off a master motor or to provide a feedback signal to the automation system indicating damper position. Accuracy shall be within + or - 2.5%.

E. Miscellaneous Damper Actuators
1. Exhaust fan damper actuators shall be 2 position spring return closed if any water piping, coils or other equipment in the space which the damper serves needs to be protected from freezing; otherwise, drive open, drive closed type 2 position may be used. The minimum torque for any actuator shall be 50 lb.-in.
2. Provide auxiliary switches on damper shaft or blade switch to prove damper has opened on all air handling equipment handling 100% outside air and greater than 2.5" TSP.
3. Combination Smoke and Fire Damper Actuators
a. Actuators shall be factory mounted and connected to the damper section and shall conform to UL 555S specifications. They shall be rated for 350°F.

A. Valves shall be selected for control characteristics to match flow and pressure drop requirements in lieu of matching line size.

B. Control valves selected for pressure drop as follows:
1. Terminal Units: 100-150% of terminal unit pressure drop, but not to exceed 3 PSI.
2. Coil Three Way Valves: 100-150% of coil pressure drop, but not to exceed 6 PSI.

C. Valve Actuators
1. General Requirements
a. Electronic actuators shall be electric, direct coupled type capable of being mounted over the shaft of the damper. They shall be UL listed and the manufacturer shall provide a 2-year unconditional warranty from the date of commissioning. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators. Sound level shall not exceed 45 dB for high torque nor 35 dB for VAV actuators.
b. Electronic overload protection shall protect actuator motor from damage. If damper jams, actuator shall not burn-out. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.
2. Control Valves Actuators (3 inch and smaller)
a. Actuators shall have a gear release button on all non-spring return models to allow manual setting. The actuator shall have either an insulating air gap between it and the linkage or a non-conducting thermoplastic linkage. Care shall be taken to maintain the actuator's operating temperatures and humidity within its specifications. Pipes shall be fully insulated, and heat shields shall be installed if necessary. Condensation may not form on actuators and shall be prevented by a combination of insulation, air gap, or other thermal break.
b. The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within 1/21 of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating valve position.
c. Valve body and actuators shall be shipped fully assembled and tested at the valve factory prior to shipment.
d. Control valves mounted in air handler piping enclosures shall be rated for exterior installation, minimum NEMA 3R.

2.7 WEB USER INTERFACE

A. Interface shall provide the interface between the LAN or WAN and the field control devices and the global supervisory control functions over the control devices connected to the controller. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization by means of Atomic clock Internet site including automatic synchronization.
   6. Integration of LonWorks controller data and BACnet controller data.
   7. Network Management functions for all LonWorks devices.

B. The controller shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the controller shall be an ODBC compliant database or must provide and ODBC data access mechanism to read and write data stored in it.

C. The controller shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 64 simultaneous users.

D. Even Alarm Notification and Actions
   1. The controller shall provide alarm recognition storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   2. The controller shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection or wide-area network.
   3. Alarm generation shall be selectable for annunciation type and acknowledgment requirements including but not limited to:
      a. To alarm
      b. Return to normal
      c. To fault
   4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e. security, HVAC, Fire, etc.
   5. Provide timed (schedule) routing of alarms by class, object group or node.
   6. Provide alarm generation from binary object “runtime” and/or events counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
   7. Control Equipment and network failures shall be treated as alarms and annunciated.
   8. Alarms shall be annunciated in any of the following manners as defined by the user:
      a. Screen message text.
      b. Email of the complete alarm message to multiple recipients. Provide the ability to route alarms based on:
         1) Day of week
         2) Time of day
         3) Recipient
      c. Pagers via paging services that initiate a page on receipt of email message.
      d. Graphic with flashing alarm object(s).
      e. Printed message routed directly to a dedicated alarm printer.
   9. The following shall be recorded for each alarm:
      a. Time and date
      b. Location (building, floor, zone, office number, etc.)
      c. Equipment (air handler #, access way, etc.)
      d. Acknowledgement time, date and user who issued acknowledgement.
      e. Number of occurrences since last acknowledgment
   10. Alarm actions may be initiated by user defined programmable objects created for that purpose.

11. Defined users shall be given proper access to acknowledgment any alarm, or specific types or classes of alarms defined by the user.
12. A log of all alarms shall be maintained by the controller and shall be available to the user.
13. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available to the user.

E. Data collection and storage
1. The controller shall have the ability to collect data for any property of any object and store this data for future use.
   a. Controller shall have sufficient capacity to support existing, proposed and an additional 30% more control points.
2. The data collection shall be performed by log objects, resident in the controller shall have, at a minimum, the following configurable properties:
   a. Designating the log as interval or deviation
   b. For interval logs, the objects shall be configured for the time of day, day of the week and sample collection interval.
   c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
   d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
   e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

F. All log data shall be stored in a relational database in the controller and the data shall be accessed from the server or a standard web browser.

G. All logs data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

H. All log data shall be available to the user in the following formats:
1. HTML
2. XML
3. Plain Text
4. Comma or tab separated values

I. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SQL Servera, Oracle *I or Expressa, Hyperion Solutions SQL Servier.

J. Unit shall be Tridium™. Contractor is responsible for accessing existing building controls prior to submitting pricing to insure they are able to interface with existing building components.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install all control components in accordance with manufacturer's instructions and recommendations.

B. Provide mixing dampers of parallel blade construction arranged to mix streams. Provide separate minimum outside air damper section adjacent to variable outside air damper.

C. Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved lamicoid nameplates on cabinet face.

D. Install “Hand/Off/Auto" selector switches to override automatic interlock controls when switch is in "Hand" position.

E. After completion of installation, test and adjust control equipment. Submit data showing setpoints and final adjustments of controls.

F. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

G. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

H. Install all equipment in readily accessible location as defined by Chapter 1, Article 100, Part A of the NEC.

I. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

J. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.2 ELECTRICAL SYSTEM INSTALLATION

A. Comply with all Division 16 Installation Requirements. Communications cabling shall meet factory requirements for data transfer rate. Minimum cable requirements Cat 5e.

B. Install low voltage power and communication trunks in conduit in the following locations regardless of local building code allowances otherwise.
1. Mechanical rooms.
2. Electrical rooms.
3. Vertical risers (Exception: fire rated continuous closet like a telephone closet).
4. Open Areas where the wiring will be exposed to view or tampering.

C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

D. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums and beneath computer access floor, approved cables not in raceway may be used provided that:
1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

E. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

F. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 10 ft intervals.

G. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

H. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

I. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

J. Set conduits as follows:
   1. Expanding silicone firestopping material sealed watertight where conduit is run between floors through walls of fireproof shaft.

K. Cap open ends of conduits until conductors are installed.

L. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

M. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

N. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

O. Where wiring is installed exposed in occupied spaces, all wiring shall be installed in surface raceway as required by Division 16000.

3.3 TEMPERATURE SENSORS

A. Temperature sensors shall require no field calibrations. Temperature sensors shall not include adjustment or space temperature adjustment unless specifically indicated on the drawings.

B. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.

C. Strap-on mountings, utilizing helical screw stainless steel clamps, shall only be permitted on hot water piping up to 2 inches. All other water temperature sensors shall be in wells.

D. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.

E. Sensors shall be with enclosure where located in finished space.

F. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and

so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

G. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well.

3.4 WARNING LABELS

A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

CAUTION
This equipment is operating under automatic control and may start at any time without warning.

3.5 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 3/8” letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to terminal box or valves with nameplates.

3.6 CLEANING

A. This Contractor shall clean up all debris resulting from his or her activities daily. The Contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.7 PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage and shall carefully store material and equipment received on-site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.8 FIELD QUALITY CONTROL

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and/or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.9 CHECK OUT, START UP AND TESTING

A. The control system shall be properly commissioned prior to acceptance. The Contractor shall coordinate with others (including mechanical, electrical and test and balance) to properly start up and verify the operation of the system. Provide as-built documentation as detailed in Part 1 of this Section.

B. Contents of O&M Manual:
   1. Provide a Table of Contents
   2. Include the following information in the Maintenance Manual in an Introduction section following the Table of Contents:
      a. Alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
      b. Contractor’s name, address and telephone number.
      c. Name, signature and title of Contractor’s Representative responsible for preparation of technical manual.
      d. Date of issuance of manual and revision number.
      e. Contractor’s job control number.

C. Include the following information as a minimum in the section Number 1, “General.”
   1. Valve tag list. (Coordinate with Mechanical Contractor).
   2. Proper lubricants and lubricating instructions for each piece of equipment, date when lubricated, and recommended frequency of lubrication.
   3. Table of multi-conductor cable tag number and corresponding system and building, floor or area served.

D. Charts showing normal operating conditions and points of high and low limit alarms.

E. Routine preventive maintenance procedures and corrective diagnostic trouble shooting procedures.

F. Parts list with manufacturer's catalog numbers and manufacturer's order information. All information should be organized by individual equipment type, i.e., valves, dampers, controllers, etc., and with heavy paper dividers or individual equipment tabs

G. Installation instructions for each piece of equipment installed under this division.

H. List of ordinary and special tools, operating materials and supplies and test equipment recommended for operation and servicing.

I. Detailed description of modifications made to standard catalog equipment

3.10 ACCEPTANCE

A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's Representative. Such tests shall then be performed as part of the warranty.

3.11 PROGRAMMING

A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the HVAC Control System Contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements reflect the language used in the sequence of operations.

D. Operators' Interface
   1. Standard Graphics.
      a. Provide graphics for each new piece of equipment and any floor plan revisions in the building. This includes each Air Handler, Air Terminal Unit, Fintube section, Exhaust Fans, etc. These standard graphics shall show all points dynamically as specified in the points list.
      b. Provide graphic for each building floor indicating location of all controlled equipment. Individual equipment graphic shall be linked to this screen to allow operator to navigate from floor plan to equipment.
      c. Floor plan graphic should through color representation allow visual indication of space temperature. Color shall vary based on deviation from setpoint.
      d. System control diagrams shall indicate all required control points as per control points schedule.
   2. The Controls Contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this

section. This includes any operating system software, the operator interface data base, and any third-party software installation and integration required for successful operation of the operator interface.

3. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The Contractor shall dedicate a minimum of 2 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection and permits acceptance of the delivered system for on-line operation.
4. Contractor is responsible for securing access to the Building's Ethernet LAN and all associated wiring.

3.12 USER INTERACE

A. The Contractor is responsible for setting up the operating terminal so that communication is possible with the following:
   1. Individual control panels.
   2. Off-site communication via Ethernet.

B. The Contractor is responsible for any and all wiring required for connection to the building phone system and LAN network.
   1. Owner will provide (1) static IP address to the building network for system communication.

C. All system graphics shall be available.

D. The Controls Contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third-party software installation and integration required for successful operation of the operator interface.

E. The terminal shall be available during training.

END OF SECTION 15900

SECTION 15940 – MECHANICAL OPERATING SEQUENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all engineering, labor, materials, and service necessary to provide system operation as described in this section.

PART 2 - PRODUCTS

2.1 REFERENCE

A. Applicable systems, equipment and products are specified in Section 15900.

PART 3 - EXECUTION

3.1 HEATING SOURCE

A. Boilers
   1. Boiler controls shall be deactivated when outdoor air temperature rises above 60°F (adjustable) and all building spaces are calling for cooling or OAT rises above 65°F.
   2. Provide an alarm to digital control system upon boiler failure and/or drop in system water temperature of 20°F below setpoint
   3. Provide system reset schedule versus outside air temperature of 100°F at 60°F OAT and 160°F at 10°F and below OAT.
   4. Boiler system will utilize three modular boilers
      a. Individual module modulation shall be provided by the temperature control system. Provide control signal to boilers to modulate individual boiler fire rate.
      b. Wiring and programming coordination shall be responsibility of the Temperature Control Contractor
      c. Temperature Control Contractor to modulate individual boiler rate to maintain the following reset schedule:
         1) Reset building hydronic loop when OAT is below 60°F as follows:
            a) 100°F at 60°F OAT (adjustable)
            b) 160°F at 10°F OAT and below (adjustable)
            c) Reset loop temperature down is building spaces are within 1°F of setpoint and loop differential is less than 10°F (adjustable)
         2) Stage Lag boiler ‘ON’ when Lead boiler reaches 90% or greater for more than 15 minutes. Stage Lag Boiler ‘OFF’ when bother boiler firing rate drops below 35% for more than 5 minutes.
         3) Stage parallel boiler rates as a single firing rate.
         4) If Lead boiler has operated at a fire rate of less than 5% for more than 30 minutes cycle boiler off till loop return water temperature drops to 20°F below setpoint then re-energize boilers. Upon reactivation limit boiler fire rate to 20% to restore loop temperature.

5. Dedicated boiler pumps shall operate continually during boiler operation. Pump shall remain in operation for thirty seconds after the boiler operation. Reset pump speed to match unit performance.
    a. Contractor to set-up dedicate boiler pump to allow boiler controller to modulate pump speed to maintain 30°F delta T thru the boiler during operation. See boiler instructions to set pump at Analog input; Range Min to 0; Range Max to 100; Signal to 0-10v; Setpoint Influence – Linear with min; Control Mode – Constant Curve

B. Circulation Pumps
1. Hydronic System Pumps (HWP-1 and 2)
    a. Pumps operate continuously when building is occupied and there is a call for mechanical heating or cooling, or the OAT is blow 60°F. The pumping system is enabled to maintain constant system differential pressure adequate to ensure proper flow through building ventilation equipment.
    b. Provide flow switch to verify pump operation. Stand-by pumps to operate as Lag pump during its operation. Provide test sequence to simulate failure of either Pump. Alarm equipment failure.
    c. Pump internal controls shall be set to maintain constant system differential pressure. Units shall modulate to maintain system pressure based on factory mounted control.
    d. Extend network control to the pump BMS interface module.

3.2 SYSTEM ALARMS

A. Building alarms shall utilize BAC Net™ protocol for prioritizing.

B. Provide the following status alarms:
1. Equipment status
2. Hydronic system static pressure drops below 10 psi.
3. Boiler Function
    a. Supply water temperature falls 20°F below set point. Alarm only available if OAT is below 40°F (adjustable.)
4. Space temperature drops 5°F below setpoint and unit discharge air temperature is below 75°F.

C. Maintenance Reminders
1. Run time reminders
2. Scheduled filter change reminders

D. Status alarms shall be sent via email to Owner-designated personnel; maintenance reminders shall remain at User interface terminal in separate folder with personnel notification through pop-up note.

3.3 POINT LIST – see page following

END OF SECTION 15940

SECTION 15950 – TESTING, ADJUSTING AND BALANCING (TAB)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes TAB to produce design objectives for the following:
   1. Hydronic Piping Systems:
      a. Constant flow systems.
   2. HVAC equipment quantitative performance settings.
   3. Verification that automatic control devices are functioning properly.
   4. Reporting results of activities and procedures specified in this Section.

1.2 SUBMITTALS

A. Strategies and Procedure Plan: Within 60 days from Contractor's Notice to Proceed, submit (10) copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms for use on this project.

B. Certified TAB Report: Submit five copies of reports prepared as specified in this Section, on approved forms certified by TAB firm.

C. Warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Tab Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. Certification of Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in the Specification.

C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilation and Air Conditioning Systems;" NEBB's "Procedural Standards for Testing Adjusting and Balancing of Environmental Systems;" SMACNA's "HVAC Systems – Testing, Adjusting and Balancing;" or TAB firm's forms submitted for approval prior to commencement of balance.

1.4 COORDINATION

A. Coordinate the efforts of factory-authorized representatives for systems and equipment, installers of HVAC controls, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on the air and water distribution systems have been satisfactorily completed per the project Engineer.

1.5 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the contract Documents.

1.6 SYSTEM DESCRIPTION

A. System Requirements:
   1. Balance all new and modified hydronic systems including all individual coils and terminal units.
      a. Provide flow information for all flows indicated on the drawings.
      b. Provide total equipment performance information for all scheduled equipment.
   2. Test system to establish required pump differential pressure setpoint.
   3. Set unit three-way by-pass to maintain minimum flow setpoint through the boilers.

PART 2 – PRODUCTS – Not applicable

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings and manual volume dampers are required by the Contract documents. Verify that qualities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Related performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions and thereby cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems-Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examined system and equipment installations to verify that they are complete, and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers are properly installed and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume devices to verify that they are accessible, and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine three-way control valves for proper installation for their intended function of mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine system pumps to ensure absence of entrained air in suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:
1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and open positions.
4. Thermostats are located to avoid adverse effects of sunlight, drafts and cold walls.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.
7. Controller set points are set at indicated values.
8. Interlocked systems are operating.
9. Changeover from heating to cooling mode occurs according to indicated values.

R. Examine variable speed drives to verify proper function.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to change conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare TAB plane that includes strategies and step-by-step procedures.

B. Complete readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean and free of air.
3. Automatic temperature control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.
7. Ceiling are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so that indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems;" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems;" or SMACNA's "HVAC Systems – Testing, Adjusting, and Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets to the minimum extent necessary for installation of test probes to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new material identical to those removed. Restore vapor barrier and finish according to insulation Specifications for the Project. See Section 15100.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper control positions, valve position indicators, fan-speed-control levers and similar controls and devices to show final settings.

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5%.

B. Prepare schematic diagrams of systems "As-Built" piping layouts.

C. Prepare hydronics for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check make-up water station pressure gauge for adequate pressure for highest vent.
4. Check flow control valves for specified sequences of operation and set at indicated flow.
5. Set differential pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump motor load. If motor is overloaded, throttle main flow-balancing devices so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
9. Place all units in full cooling as necessary to verify variable flow conditions.

3.5 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive displacement pumps:
1. Verify impeller size by operating the pump within the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in

gauge heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated pre-settings.

C. Measure flow stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rates as follows:
1. Determine the balancing station with the highest percentage over indicated.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record setting and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor air temperature.

G. Measure the differential pressure control valve settings existing at the conclusions of balancing.

3.6 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
1. Heating water flow rate: 0 to minus 10 percent.

3.7 FINAL REPORT

A. General: Typewritten, or computer printout in letter quality font, on standard bond paper, in three ring binder, tabulated and divided into section by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
1. Include a list of instruments used for procedures along with proof of calibration.

C. Final Report Comments: In addition to certified field report data, include the following:
1. Pump curves.
2. Fan curves.
3. Manufacturer test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title Page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Engineer’s name and address.
   6. Contractor’s name and address.
   7. Report data.
   8. Signature of TAB firm certifying the report.
   9. Table of contents with the total number of pages defined for each section of the report. Number each page of the report.
   10. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   11. Nomenclature sheets for each item of equipment.
   12. Data for terminal units, including manufacturer, type size and fittings.
   13. Notes to explain why certain final data in the body of reports varies from indicated values.
   14. Test conditions for fans and pump performance forms including the following:
      a. Setting for outside, return and exhaust air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet and dry bulb conditions.
      d. Fan drive settings including settings and percentage of maximum pitch diameter.
      e. Settings for supply air, static pressure controllers.
      f. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single line diagram and include the following:
   1. Quantities of outside, supply, return and exhaust airflows.
   2. Water flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.
   6. Balancing stations.
   7. Position of balancing devices.

END OF SECTION 15950

SPECIFICATIONS - DIVISION 16 - ELECTRICAL

DIVISION 16 – ELECTRICAL

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SECTION 16010 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general provisions specific to the performance of Electrical Work.

B. Related Documents: The provisions, terms and requirements of Instructions to Bidders, General Conditions and Supplementary Conditions and the Applicable Drawings and Technical Specifications herein apply to work under this Division.

1.2 DESCRIPTION

A. This work consists of, but is not necessarily limited to, the furnishing of all plant, labor, equipment, appliances and materials and the performance of all operations in connection with the installation of all electrical work complete, in strict accordance with specifications and/or drawings, including incidentals necessary and required for their completion.

B. Note alternates listed and account for any change in the work and include any price deemed necessary to meet the requirements of the respective alternate. See General Requirements for Schedule of Alternates.

C. Drawings are partly diagrammatic, and do not necessarily show the exact routing of conduits or location of products, nor minute detail of all features of the installation.

D. Risers and other diagrams are schematic only, not to scale, and do not necessarily show the physical arrangement of the equipment. Do not use riser diagrams to obtain lineal runs.

E. Specifications are of the abbreviated or "streamlined" type and include incomplete sentences. Omissions of words or phrases such as "the Contractor shall", "in conformity with", "shall be", etc., are intentional. Omitted words or phrases shall be supplied by inference.

1.3 QUALITY ASSURANCE

A. Workmanship shall be by workers skilled in particular trade in conformance with best practices.

B. Work shall contribute to efficiency of operation, access, maintenance, appearance. No part of installation shall interfere with operation of any other system or parts of building.

C. Materials or equipment not properly installed or finished shall be repaired or replaced as hereinafter provided under Guaranty-Warranty.

D. Guaranty-Warranty - See General Conditions for work under this Section, and mechanical sections within where special warranty conditions are noted.

1.4 RESPONSIBILITY

A. The Contractor shall be responsible for installation of satisfactory and complete piece of work in accordance with intent of drawings and specifications, providing all incidental items required for completion of work whether or not specifically mentioned or indicated in specifications or on drawings.

B. Consult all drawings for project, shop drawings of other trades, building dimensions, to predetermine that work and equipment will fit as intended. Particularly close attention should be paid to architectural and mechanical equipment locations prior to rough-in.

C. Check location of conduits, panels, outlets, equipment, switches, etc., to verify clearance from all openings, structural members, cabinets, heating units, ducts, piping, equipment having fixed locations, etc., and proper concealment above, behind or within finished surfaces.

D. Changes in the location of conduits, outlets, fixtures, switches, panels, equipment, etc., if necessary due to obstacles or work of other trades, shall be made by Contractor at no extra cost.

E. Prior to submitting bid, visit site of project and ascertain conditions affecting proposed work and make allowances as to cost thereof.

F. Coordinate all work with the serving utility (power) and provide equipment and installation in accordance with the respective utility requirements. If any conflicts are found the Electrical Contractor shall advise the Engineer immediately and modify the system (prior to bidding) as required by utility. Provide to the Engineer a written statement of approval from the serving utility.

1.5 COORDINATION

A. Coordinate the work to proceed with minimum interference with other trades.

B. Inform General Contractor of all openings required in building structure for installation of work.

C. Check all dimensions of equipment installed or provided by others so correct clearance and connections can be made.

PART 2 - PRODUCTS – Not applicable

PART 3 - EXECUTION

3.1 OPENINGS

A. Openings in conduits, boxes, etc., shall be kept closed during progress of work. Clean systems found dirty to satisfaction of the Engineer and at no additional cost.

3.2 CUTTING, PATCHING AND FRAMING

A. Chases, openings, sleeves, hangers, anchors, recesses, equipment, pads, framing for fixtures, are provided by the Electrical Contractor for his work.

B. Electrical Contractor shall be responsible for correct size and locations of chases, equipment pads, curbs, etc., whether provided by the Electrical Contractor or others.

C. Cutting and patching that is required for the installation of Electrical work is the responsibility of the Electrical Contractor under the supervision of the Engineer. The Electrical Contractor is responsible for repairing all surfaces cut and patched to match the existing surfaces.

3.3 ACCESS AND CLEARANCE

A. Provide access and clearance to junction boxes, cabinets, items requiring service; including access doors through ceilings and walls where required.

3.4 PAINTING

A. Electrical equipment shall be provided with standard finish and color, except if manufacturer has no standard finish, equipment must have prime coat of paint. Note exceptions where specific finish or color or choice is specified.

3.5 RECORD DRAWINGS

A. Keep separate set of Electrical Drawings at site for use as "Record Drawings". Mark drawings to show locations of electrical work which will become permanently concealed, cast in concrete, buried underground, or concealed in blind spaces. Show complete routing and sizing of any significant revisions to the system on drawings. These drawings shall be included with "Brochure of Equipment", hereinafter specified.

END OF SECTION 16010

SECTION 16015 - LOCAL CONDITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements pertaining to conditions at the project location.

1.2 REFERENCES

A. All work shall be in accordance with applicable local, state, and national codes and national codes and ordinances and utility company regulations; including, but not limited to the latest legally enacted editions of the following:
   1. National Fire Protection Association (NFPA)
   2. National Electrical Code (NEC)
   3. International Building Code (IBC)
   4. International Energy Conservation Code (IECC)

B. The following references infer that installation, equipment, and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
   1. American National Standards Institute (ANSI)
   2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   3. Institute of Electrical and Electronics Engineers (IEEE)
   4. Insulated Cable Engineers Association (ICEA)
   5. National Electrical Contractors Association (NECA)
   6. National Electrical Manufacturers Association (NEMA)
   7. National Fire Protection Association (NFPA)
   8. Underwriters Laboratories, Inc. (UL)

1.3 PERMITS AND TESTING

A. The Contractor shall pay for all permits or fees in connection with the work.

B. Final Tests: Prior to the final test, all switches, devices, panelboards and fixtures shall be in place.

1.4 ALTERATIONS

A. Changes or revisions may be made to suit job conditions if such changes meet local codes and make for an equal or better job. Review such modifications with Engineer prior to implementation.

PART 2 - PRODUCTS – Not applicable.

PART 3 - EXECUTION

3.1 CLEAN-UP

A. Upon completion of work, remove materials, scraps, etc., related to the work and leave premises, including all tunnels, attics, ceilings, and crawl spaces, in clean and orderly condition. Clean equipment of dirt and debris including interior of panels, outlet boxes, etc. Remove labels on fixture lens.

END OF SECTION 16015

SECTION 16020 - MATERIALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for Materials to be used in the Electrical Work.

B. Related Documents: Division 1, General Requirements

1.2 RESPONSIBILITIES

A. Provide for delivery and storage of required materials. Store equipment and materials such that they are protected, easily checked and inspected. Store materials up off ground on blocking. Protect electrical gear with plastic tarps.

B. Arrange with General Contractor and Owner for introduction of equipment too large to pass through finished openings.

C. Protect materials and equipment installed under this Contract and protect materials and equipment of others from damage as result of this Work.

1.3 SUBMITTALS

A. See General Conditions.

B. Within thirty (30) days of the award of Contract, the prime Electrical Contractor shall provide submittals for the materials to be provided. Submittals for each portion of the work (i.e. light fixtures, panels, starters, etc.) bound in booklet form with all items in order consistent with specifications and/or schedules.

C. Submittals must:
1. Be accompanied by a Transmittal Form or cover sheet having the Contractor’s signature and the Supplier’s signature on all copies attesting to the correctness and compliance of the submittal and identifying the Specification section for material submitted. Copies shall be in brochure form, with index tabs indicating the Specification Section; i.e., 16140 - Wiring Devices, etc.
2. Be legible original literature clearly indicating the manufacturer and the type of product proposed.
    a. **FAX pages are not acceptable.**
    b. Photocopies of previously faxed pages are not acceptable.
    c. Web page prints are not acceptable.
3. Include Shop Drawings detailing any engineering changes necessary to implement installation of substituted materials.

D. Where reproduction or delivery schedules of specified equipment interfere with construction schedules, the Electrical Contractor shall submit a letter from the manufacturer or supplier showing proposed delivery schedule for the item in question along with submittals or proposed substitution with delivery schedule for review and acceptance by the Engineer.

E. Product Data shall include manufacturer's literature indicating manufacturer, specific items used, sizes, dimensions, capacities, rough-in requirements, installation, maintenance, operating instructions and wiring diagrams.

F. Shop Drawings shall provide complete details of the proposed layout and installation of systems and equipment as specifically required for this project.

G. Submittals marked “Revise and Resubmit" shall be changed and resubmitted until correct and /or complete enough for review.

H. Review of Submittals shall not relieve Contractor from responsibility for deviations from drawings, or specifications unless he has in writing called Engineer's attention to such deviations and secured his written acknowledgment, nor shall it relieve him from responsibility for errors in Submittals or literature.

I. Changes - Shop Drawings on substituted equipment shall include any drawings and engineering changes necessary to implement installation of substituted equipment.

J. Schedule

SPEC. SECTION	MATERIAL DESCRIPTION	PROD DATA	SHOP DRWG	EO&M BOOK	WIRE DIAG
16060	Grounding	X	X		
16120	Wire & Cables	X	X		
16130	Conduit & Fittings	X	X	X	X
16131	Surface Raceway	X	X	X	
16140	Wiring Devices	X	X		
16410	Disconnects	X	X	X	
16420	Motor Starters	X	X	X	
16490	Overcurrent Protective Devices	X	X	X	

END OF SECTION 16020

SECTION 16025 - REMODEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements related to coordinating the work with existing conditions.

1.2 SYSTEM DESCRIPTION

A. Design Requirements
   1. Construction operations will coincide with the Owner’s continued occupancy and use of building.

B. Performance Requirements
   1. Connections and work within existing building shall be performed with minimum inconvenience to Owner.
   2. Demolition or construction may require rerouting circuits or relocating devices. Also, circuits may have to be extended to keep remaining electrical devices energized. All such work shall be included in the contract price.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials used shall be as specified under Division 16.

PART 3 - EXECUTION

3.1 GENERAL

A. Material removed remains property of the Owner and shall be removed by Contractor to location on site selected by Owner. Material not retained by the Owner shall be removed from site and disposed of lawfully.

B. Disconnect and remove existing fixtures, wiring devices, panels, disconnects, conduit, wire, etc., as noted or required.

C. Unless specifically indicated on plans, verify point of origination of power for circuitry and continue circuits as required when circuit is interrupted for removal of equipment, etc.

D. Install new fixtures, wiring devices, panel, etc., as noted including new conductors, conduit, and surface raceways as noted.

E. Blank recessed outlet boxes not reused with a finished plate.

3.2 REVISIONS

A. Should any existing piping or ductwork be encountered which interferes with the proper installation of the new work, Electrical Contractor shall relocate his circuiting or equipment as directed by the Engineer.

B. Changes or revisions may be made to suit job conditions if such changes meet local codes, are approved by Engineer, and make for an equal or better job.

END OF SECTION 16025

SECTION 16050 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes specific requirements, products, and methods of execution which are typical throughout the electrical work of this project. Additional requirements for the specific systems, may modify these requirements. Refer also to drawings/plans for equipment schedules.

B. Related Work:

1. Temperature Control Wiring specified in Division 15.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Only materials designed for the purpose employed shall be used.

B. Materials shall be identical with apparatus or equipment which has been in successful operation for at least two years. All materials of similar class or service shall be of one manufacturer.

C. Capacities, sizes, and dimensions given are minimum unless otherwise indicated. All systems, materials and equipment proposed for use on this project shall be subject to review for adequacy and compliance with Contract Documents.

2.2 MATERIAL AND EQUIPMENT FURNISHED IN OTHER DIVISIONS

A. Provide complete power connections to equipment including but not limited to feeders, connections, disconnects, and motor running overcurrent protection. Where starters are provided as part of a packaged equipment, overcurrent heaters shall be provided by the Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All work on the project that falls under the jurisdiction of the electrical trade shall be performed by Licensed Electricians in conformance with the electrical specifications.

B. All motors, starters, boxes, disconnects, etc., shall be set level, plumb, and firmly anchored to structure. No system shall be supported from ductwork, fire sprinkler, or any other system.

C. Repair all surfaces to match existing in materials and finish. Furnish all required material and labor to maintain fireproof, airtight, and waterproof characteristics of the construction.

D. Installation of all equipment shall be in accordance with manufacturer's instructions and local adopted code requirements.

3.2 GENERAL MOUNTING HEIGHTS

A. Mounting heights of junction boxes or equipment shall be above finished floor (AFF) as scheduled below or as shown on the work.

B. Mounting heights of controls are intended to meet the accessibility requirements of ANSI A117.1. Mounting heights of alarm devices are intended to meet the accessibility requirements of ANSI A117.1 and conform to NFPA 72, Standard for Fire Alarm Systems. Contractor shall inform the Engineer of any conflicts with required mounting heights prior to moving such devices.

C. Schedule: All items shown may not be applicable to this project.

ITEM	Height (Inches)
Controls – Unobstructed Reach Lighting Switches Adjustable Thermostats Fire Alarm Pull Stations Emergency/ Shunt Trip Pushbuttons Door Operator Pushbuttons	Top J-Box 48
Controls – Obstructed Reach	Top J-Box 44
Alarms – Audible Only Fire	Top J-Box 96” (Minimum: Top 90” Or Top 6” Below Ceiling)
Alarms – Visible Fire (Including Audible/Visible)	Top J-Box 96 Or Top 6 Below Ceiling (Minimum: Bottom 80)
Egress Lighting, Wall Paks	Top J-Box 96 Or Top 6 Below Ceiling (Minimum: Bottom 80)
Bracket Lights	Center J-Box 84
Outlets – Interior, Unobstructed Convenience, Phone, Data, TV	Top J-Box 18 (Top 16 in Masonry)
Outlets – Interior Mechanical, Boiler and Work Rooms	Top J-Box 48
Outlets – Exterior WP	Top J-Box 24
Safety Switches, Motor Controllers, Variable Frequency Drives	Top 66
Special System Panels – Control, Fire Alarm, Clock & Program, Sound, Dimming	Top 66
Electric Meter Base	Top 72
Panelboards	Top 74
Telephone Panels or Cabinets	Top 74
Circuit Transformers, Enclosure Free-Standing Wall Mount	Top 60 Top 84

END OF SECTION 16050

SECTION 16060 - GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for a grounding system.

1.2 SYSTEM DESCRIPTION

A. Design Requirements
   1. Unless specified elsewhere, the ohmic values for grounds and grounding systems shall be as specified in this section.
   2. For grounding secondary distribution systems, neutrals, non-current carrying metal parts associated with distribution systems, and enclosures of electrical equipment not normally within reach of other than authorized and qualified electrical operating and maintenance personnel -- 25 ohms maximum.
   3. For individual transformer and lightning arrester grounds on distribution systems -- 10 ohms maximum.
   4. For equipment not covered in the above -- 10 ohms maximum.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Conductor: Product of General Cable, Phelps-Dodge, American Wire and Cable, Southwire, Triangle.

B. Rod: Product of Hubbard, Robbins, Thompson.

2.2 REQUIREMENTS

A. All grounding conductors and equipment required for ground systems shall be in accordance with UL 467 and as follows: Ground rods shall be 5/8" x 10-foot copper clad steel; grounding conductor for building service ground shall be bare copper; and grounding conductor for telephone service entrance and panels shall be #4 bare copper, with 6'-0" slack cable at each panel. Minimum of 2 ground rods 6 ft. apart.

B. Connections: Joints in grounding conductors and mats below grade shall be made with solderless compression connections or with Cadweld™ equipment. Terminations above grade shall be made with solderless lugs, securely bolted in place.

C. Install in strict accord with the NEC with ground to water service ahead of meter and to ground rods. Jumper across water meter.

PART 3 - EXECUTION

3.1 SERVICE GROUND

1. The commercial system’s grounded neutral conductor and, if installed, the stand-by generator frame.

2. All metallic water services to the building. If insulated ground conductor is installed in conduit, both ends of conduit shall be bonded to ground conductor.

3. All "man-made" grounds specified shall be installed.

4. The service entrance equipment and all conduits entering and leaving the equipment.

5. Reinforcing steel in slab and footings.

6. Structural steel columns (one, minimum).

7. Other items or equipment called for on the drawings or required by code.

3.2 EQUIPMENT GROUND

A. Contractor has the option to bond to the building structure per NEC requirements.

B. All conduit systems, including the surface metal raceways, shall have continuous ground conductor throughout conduit system. Conduit shall not be relied upon as sole equipment grounding means.

END OF SECTION 16060

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for marking raceways and equipment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS AND NAMEPLATES

A. Provide rigid engraved labels and nameplates of laminated plastic 1/16-inch-thick with black letters on a white background. Label emergency equipment red background and white letters. No labeling abbreviations will be permitted without prior approval.

PART 3 - EXECUTION

3.1 EQUIPMENT LABELS AND NAMEPLATES

A. Securely attach labels with silicone rubber sealant and screws.

B. Provide 1/4" minimum height letters on: Disconnects and starters for motors or fixed appliances. (Include item designation and branch feeder number, i.e., FAN #4, MCC-2); Designated electrical equipment.

C. Provide 1/8" minimum height letters on engraved device plates on switches and receptacles where item controlled is not visible from the switch, or as noted on drawings.

D. Temporary markings are not permitted on equipment. Repaint trims, housings, etc., where markings cannot be readily removed. Refinish defaced finishes.

3.2 BRANCH CICUIT PANELBOARD DIRECTORIES

A. Provide neatly typed or computer printed schedule (odd numbered circuits on left side or top, even on right side or bottom) under plastic jacket or protective cover to protect the schedule from damage or dirt. Securely mount on inside face of panelboard door. Define briefly, but accurately, nature of connected load (i.e., Lighting Room 102, Receptacles Boiler Room, etc.) as approved. Provide similar typed directory for contactor cabinet.

3.3 EMPTY CONDUITS

A. Provide tags with typed description of purpose and location of opposite end, wired to each end of conduits provided for future equipment.

3.4 JUNCTION BOXES

A. Mark the circuits numbers of wiring on all junction boxes with sheet steel covers. Mark with indelible black marker. On exposed junction boxes in public places, mark on inside of cover.

3.5 CONDUITS, POWER

A. Mark all conduits entering or leaving panelboards with indelible marker with the circuit numbers of the circuits indicated.

END OF SECTION 16075

SECTION 16120 - WIRE AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Wire and cable with insulation rated 600 volts or less.

B. Additional requirements for other electrical or special system applications shall be as described elsewhere in the Contract Documents or as required by the intended use.

1.2 REFERENCES

A. National Fire Protection Association (NFPA)
   1. NFPA70 – National Electric Code (NEC)

B. Underwriters Laboratories (UL)
   1. UL 1581 – Reference Standard for Electrical Wires, Cables and Flexible Cords
   2. UL 44 – Thermostat-Insulated Wires and Cables
   3. UL 83 – Thermoplastic – Insulated Wires and Cables

C. American Society of Testing and Materials (ASTM)
   1. ASTM B3 - Soft or Annealed Copper Wire
   2. ASTM B8 - Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
   3. ASTM B 787-19 Wire combination Unilay-Stranded Copper conductors for Subsequent Insulation

D. American National Standards Institute (ANSI)

E. Insulated Cable Engineers Association (ICEA)

F. Federal Specifications (FS) Applicable Standards

1.3 SUBMITTALS

A. Substitutions: Approval required prior to Bid.

B. Closeout Submittals: Include the following for the Operation and Maintenance Manuals:
   1. Product data as required above.
   2. As-Built Drawings showing cable routing.

1.4 SYSTEM DESCRIPTION

A. Performance Requirements: The complete installed power distribution system shall meet the following tolerances (percentages are with respect to nominal system voltage):
   1. Maximum voltage drop across feeder conductors shall not exceed 3% under full load.
   2. Maximum combined voltage drop across feeder and branch circuit conductors shall not exceed 5% at furthest power outlet under full load.

B. Design Requirements:
1. Unless otherwise specified elsewhere in the Contract Documents, branch circuit wiring shall be sized as required to meet the above performance requirements. Minimum size wire is 12 AWG.
2. Conductor ampacities shall be derated as required by NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Building Wire:
1. Southwire
2. General Cable
3. Cerrowire

2.2 GENERAL REQUIREMENTS

A. Wire and Cable types not specifically listed herein or elsewhere in the Contract Documents may not be used on this project.

B. Requirements of current NEC Article 310 shall be met.

C. Conductors shall be all copper for service, feeder, and branch circuit wiring. Conductors to be bare annealed copper per ASTM B-3 with stranding per ASTM B-8 or ASTM B-787. **Aluminum conductors are not allowed**.

D. Conductors for power limited control and instrumentation circuits shall be copper or tinned copper.

E. Conductor insulation shall be rated 600 volts.

F. Conductors shall be solid for 12 AWG and 10 AWG and stranded for 8 AWG and larger. With Engineering permission, stranded 10 AWG may be used for branch circuit wiring provided devices and equipment being served have termination provisions listed and approved for such use.

G. MC cable is not acceptable unless the Electrical Contractor obtains written consent from the Engineer.

2.3 THHN, THW, THWN AND THHW

A. Wire shall be constructed, listed and tested in accordance with UL 1582, UL 83 and Federal Specification J-C-30B.

PART 3 - EXECUTION

3.1 GENERAL

A. All branch circuit and equipment connection wire shall be installed in approved conduit or raceway.

B. All control, communications, security and alarm system cable shall be installed n approved conduit or raceway.

3.2 APPLICATION

A. Wire and cable types may be used only as permitted herein or elsewhere in the plans or specifications.

B. Wire types THHN, THW, THWN, THHW, and XHHW are permitted for branch circuit wiring and equipment connection.

3.3 PREPARATION

A. Pull clean, dry, tight fitting rag through service and feeder conduits to remove all debris and moisture immediately prior to pulling wire or cable. Repeat as required until interior of conduit is clean and dry.

3.4 INSTALLATION OF CONDUIT

A. Feed wire or cable straight into conduit and pull straight out of conduit in order to ensure that the insulation or sheath is not abraded or damaged. Use sheave(s) for larger cables to facilitate feeding and pulling.

B. Do not exceed maximum tension allowed by manufacturer. Apply pulling lubricant as required to minimize required pulling force.

C. Do not bend cable below allowed minimum bending radius. Use sheaves of appropriate diameter to meet this requirement.

D. Pull all cables within the conduit simultaneously.

E. Feed cables slowly to avoid friction heating of insulation. Increase pulling force slowly. Do not jerk cable.

END OF SECTION 16120

SECTION 16130 - CONDUIT AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes conduit and conduit fittings approved for use on this project. Type, size and installation methods shall be as shown on drawing and/or required by code.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Conduit shall be sized as shown on drawings or required by NEC, whichever is larger.
   2. Minimum sizes for rigid steel conduits shall be 3/4".
   3. Minimum size for EMT and flexible conduits shall be ½" except fixture whips may be 3/8" as allowed by the NEC.
   4. Maximum size for EMT shall be 3".

B. Performance Requirements:
   1. Conduits shall be required for the following systems, and any remaining systems, unless specifically noted otherwise:
      a. Line voltage wiring 120 Volt and above.
      b. 24 Volt low voltage switching.
      c. Mechanical equipment control.
      d. Wiring Devices.
      e. Fire Alarm System.
   2. Location (concealed unless otherwise indicated): Conduit may be run exposed where specifically noted on drawings, in crawlspaces, in mechanical rooms and electrical distribution rooms.

1.3 QUALITY ASSURANCE

A. Conduit and conduit fittings shall be standard types and sizes as manufactured by a nationally recognized manufacturer of this type of materials and be in conformity with applicable standards and UL listing.

PART 2 - PRODUCTS

2.1 APPROVED TYPES OF CONDUIT

A. Electrical Metallic Tubing (EMT): Shall meet ANSI C80.3-2015, Federal Specification WW-C-583A, UL Specification # 797, and NEC Article # 358.

B. Galvanized Rigid Steel Conduit (GRC): Shall meet ANSI C80.1-2015, Federal Specification WW-C-581e, UL Specification # 6, and NEC Article # 394.

C. Intermediate Metal Conduit (IMC): Shall meet ANSI C80.6-2005, Federal Specification WW-C-581e, UL Specification # 1242, and NEC Article # 342.

D. Flexible Steel Metallic Conduit (FMC): Shall meet Federal Specification WW-C-566C, UL Specification #1, and NEC Article # 348. Aluminum conduit is not allowed.

E. Liquid-Tight Flexible Metallic Conduit (LT): Shall meet Federal Specification WW-C-566C, UL Specification # 360, and NEC Article # 346. Conduit must be steel.

F. PVC Schedule 40 and Schedule 80 (PVC): Shall meet NEMA TC2-1978, Federal Specification WC-1094A, UL Specification # 651, and NEC Article # 347.

2.2 MANUFACTURER

A. EMT, IMC, and GRC: Allied, National, Republic Steel, Triangle, Wheatland or Kaiser.

B. FLEXIBLE METALLIC CONDUIT and LT: Alflex, Electraflex, Interflex, American Flexible Conduit (AFC)

2.3 FITTINGS

A. Rigid Steel: Galvanized steel fittings. Conduit bushings shall be of the insulated types. Where grounding bushings are required, insulated grounding bushings with pressure type lugs shall be provided.

B. EMT: Steel or malleable iron fittings. Connectors shall have insulated throats when required by Code. Compression type steel couplings shall be used in wet locations and concrete walls. Set screw type steel fittings are acceptable all other locations except when prohibited by code.

C. Flexible Metal Conduit: Steel or malleable iron fittings only as approved by NEC.

D. Liquid-tight Flexible Conduit: Steel or malleable iron fittings, of a type incorporating a threaded grounding cone, nylon or plastic compression ring, and a tightening gland, providing a low resistance ground connection. All throats shall be insulated.

E. Grounding bushing on conduits 1-1/4” or larger.

F. In no case are die cast fittings acceptable.

G. Conduit shall not be exposed in all finished areas. Conduits shall be concealed in wall, above ceilings and below floors.

PART 3 - EXECUTION

3.1 GENERAL

A. All conduit shall be installed according to the National Electrical Code as a minimum requirement. Contractor shall use this section and the NEC for installation, whichever is more restrictive.

B. Exercise control and cooperate closely with Mechanical Contractor on installing conduit to realize maximum use of space and greatest clearance between conduit and hot piping. Conduit shall be installed as out of the way as possible.

C. All conduit shall be installed recessed or concealed in wall spaces or cavities.

3.2 APPLICATION REQUIREMENTS

A. Electrical Metallic Tubing (EMT): Shall be allowed for installation in or on ceilings, framed walls, furred spaces and exposed if not subject to physical damage.

B. Flexible Metallic Conduit: Shall be allowed for final connection to motors, dry-type transformers and lay-in light fixtures in dry locations only. Connections to motors, transformers, and mechanical equipment curved to a minimum of 90 degrees to minimize sound transmission. Flexible conduit may also be used in remodeling projects where EMT cannot be installed practically in an existing wall or ceiling as allowed by NEC. Ground per NEC.

C. Liquid-Tight Flexible Metallic Conduit (LT): Shall be used for connection to kitchen equipment, and areas where moisture or dampness is present. Ground per NEC.

D. PVC Schedule 40 (PVC): Shall be allowed underground for exterior lighting systems. Refer to NEC for more restrictions on the use of PVC. No PVC is allowed above grade. PVC may also be used for branch circuits or feeders in or under concrete slabs. Where conduit elbows in and out of the slab, galvanized rigid must be used. Where service entrance conduit is exposed above grade or floor, galvanized rigid must be used. Verify usage with local codes. Install PVC conduit underground in accordance with manufacturer's instructions. Expansion joints in PVC conduit where recommended by manufacturer

E. General use of MC cable is prohibited and will result in its replacement at the Contractor’s expense.

3.3 INSTALLATION REQUIREMENTS

A. All conduits shall run parallel or at right angles to the structural members of the building. Conduit shall be fastened securely to building structure per NEC. Exposed raceways shall be run parallel or perpendicular to building lines and symmetrically bent or made up with standard elbows or fittings. Concealed raceways shall be routed as directly as possible with a minimum of bends.

B. Heating conduit is not allowed. Deformed or crushed conduit shall not be installed. All bends shall be made with acceptable benders. Install straight, parallel, plumb without kinking or flattening bends. Clamps anchored to structure. Wire or plastic ties prohibited. Conduit may not be supported from ductwork, pipes, etc.

C. All conduit and tubing shall be cut square and reamed smooth at the ends and all joints made tight. Conduit threads shall be lubricated with an approved thread lubricant. Pull wires shall be installed in all spare and empty conduits. Pull wire shall be non-metallic and a working strength of 200 pounds.

D. Raceways shall be run at least 5" from parallel runs of heating system pipes, flues, or other high temperature piping systems. Raceways penetrating vapor barriers or traversing from warm to cold areas shall be sealed with a non-hardening duct sealing compound to prevent the accumulation of moisture.

E. Install ground wire in every conduit. All conduit systems, including surface raceway to have continuous ground conductor installed. Conduit shall not be solely relied upon for grounding. Ground wire is not included in wire count.

F. Pull Cables: Product of Jet Line Polyolefin - Pull line #232. Pulling line to be installed in all empty raceways including power, telephone, and special systems.

END OF SECTION 16130

SECTION 16131 - SURFACE RACEWAY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes raceway for exposed installation in finished spaces.

PART 2 - PRODUCTS

2.1 REQUIREMENTS

A. Product of Wiremold, Series 2000, 2-channel with divider, for power and data. Equivalent in Hubbell.

B. Color shall be ivory or buff or as selected by Owner.

C. Raceway, elbows, fittings, boxes, connectors, adaptors, covers, power feeds, etc., as required for complete installation.

D. Steel with corrosion resistant baked enamel buff finish, knockouts, cover, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set level, plumb, firmly anchored to structure.

B. Route in corners, at top of counter backsplash, at sides of equipment, and as inconspicuously as possible.

C. Install parallel or at right angles to walls, floor ceiling and partitions.

D. Size to house the number and size of conductors present, as well as accommodate the devices to be installed.

E. Provide a permanent divider between power and data cable runs within surface raceway.

F. Provide quadraplex, or two duplex outlets, at quadraplex outlets indicated on the plans.

G. Provide a data outlet, with blank cover plate at all surface raceway quadraplex and duplex outlet locations.

H. Coordinate all surface raceway outlet locations with Owner prior to installation.

END OF SECTION 16131

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes line voltage wiring devices.

1.2 SUBMITTALS

A. Product Data: Manufacturer’s literature.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Wiring devices are called out by manufacturer to indicate the quality required. Products of Leviton, Hubbell and Pass & Seymour are acceptable, but shall be submitted for approval. Not all devices listed here may be required for this project.

B. All devices of a particular type shall be by the same manufacturer.

C. Device colors: Black on paneled walls; white on ceilings; and ivory elsewhere or as noted. Verify standard color with Owner.

2.2 SWITCHES

A. All switches shall be Hubbell Building Automation’s wiHUBB, with wiHUBB Smart Pack plug-and-play integration, or as specified on the drawings. Color: Black on paneled walls; ivory elsewhere or as noted. Verify with Owner.

B. Standard Switches

1.	ON/OFF	WIH-SW-TO
2.	HIGH/LOW/OFF	WIH-SW-HLO
3.	ON/RAISE/LOWER/OFF	WIH-SW-ORLO
4.	PRESET/SCENE (4-Button)	WIH-SW-PRESET
5.	RAISE/LOWER	WIH-SW-RL

C. Switch with Pilot Light, Non-Lighting applications.

1.	Single Pole Toggle	Hubbell HBL 1221PLC
2.	Double Pole Toggle	Hubbell HBL 1222PL
3.	Three-Way Toggle	Hubbell HBL 1223PLC

D. Special Switches, Non-Lighting applications.

1.	SPDT, Center off, maintained	Hubbell HBL1381, HBL1381I
2.	DPDT, Center off, maintained	Hubbell HBL1382, HBL1382I
3.	SPDT, Center off, momentary	Hubbell HBL1557, HBL1557I

E. Manual Motor Starter
1. 30A Double Pole Single Throw Hubbell HBL7832D
2. 30A Double Pole Single Throw Hubbell HBL13R92D

2.3 RECEPTACLES

A. Outlets requiring ratings and configurations different from those listed below shall be provided as shown on the plans and/or as required by the equipment served and be of the same amp rating and plug configuration of equipment being supplied. Field verify equipment requirements and provide receptacles as required.

B. Provide grounding type receptacles as follows, or as required to match equipment furnished in this or other divisions.

C. Duplex Receptacles:
1. NEMA Standard configuration 5-20R, heavy duty, specification grade, side wired with screw pressure termination, 125 volts.
2. 20 A Duplex receptacle Hubbell HBL5362, HBL5362I, HBL5362W
3. 20A Four-plex receptacle (2) Hubbell HBL5362, HBL5362I, HBL5362W

D. Simplex Receptacles:
1. NEMA Standard configuration 5-20R, heavy duty, specification grade, side wired with screw pressure termination, 125 volts.
2. 20A Simplex Receptacle HBL2161I

E. Ground Fault Circuit Interrupter Duplex Receptacle:
1. NEMA Standard configuration 5-20R, 20A feed-through, 20A at receptacle, heavy duty, commercial grade, 125-volt, test and reset buttons to match face.
2. 20A GFCI duplex receptacle Hubbell HBLGF20LA, HBLCF20ILA, HBLGF20WLA

F. Combination Outlet:
1. NEMA Standard configurations NEMA 14-20R & 14-20P, dual voltage, 125/250 volts, single phase grounded.
2. 30 Amp combination receptacle Hubbell HBL9430A & HBL9431C

2.4 PLATES

A. Device and cover plates shall be brushed stainless steel unless specifically noted otherwise on Drawings; and colors per NFPA (70, 72, etc.) requirements. Device plates for 20 amp and larger devices shall be stainless steel. Cover plates for emergency outlets, and others as indicated on Drawings, are to be engraved with panel designation and circuit number supplying outlet.

B. Weatherproof receptacle covers: Impact resistant thermoplastic, weather resistant, “when-in-use” cover.
1. Single gang duplex Hubbell RW57350

C. Custom Engraving: Plates shall be engraved with a single line engraved font. Engraving depth shall be .01" minimum, not to exceed 25% of material thickness. Large lettering shall be 3/16" high with nominal .02" stroke width, and small lettering shall be 1/8" high with nominal .015" stroke width. Lettering shall be filled with black acrylic enamel. Lettering shall be sized and located on plates as indicated on drawings.

2.5 LIGHTING CONTACTORS

A. As indicated on Drawings.

B. Electrically held: Square D Class 8903, contacts rated 30A fluorescent, 20A tungsten. Coil voltage as required by intended application. Provide NEMA 1 enclosure for interior use and NEMA 3R enclosure for exterior use.

C. Mechanically held: Square D Class 8903, contacts rated 30A fluorescent, 20A tungsten. Coil voltage as required by intended application. Provide with two wire control modules. Provide NEMA 1 enclosure for interior use and NEMA 3R enclosure for exterior use.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all wiring devices indicated complete with cover plates. Cover plates shall fit snugly against finished surfaces and line up true with adjacent building lines and be symmetrical in location and appearance. Devices installed on rough or burnished block shall have block ground smooth to allow device to mount flush and perpendicular to floor.

3.2 SWITCHES

A. All switches shall be installed so their handles move in a vertical plane.

B. Door swings shall be checked on the architectural plans and, if necessary, switches shall be relocated to place them on the strike side of the door.

C. Switches mounted next to a door frame shall clear frame and built-in furniture.

D. Where switches on same voltage circuits are shown side by side, use gang boxes and plates. Space dimmers per manufacturer’s recommendations for heat release. Install barriers in all boxes where required by NEC.

3.3 RECEPTACLES

A. Prior to rough-in, verify with the architectural and mechanical plans the location and height of cabinet work to assure that outlets clear backsplash, radiation units, etc.

B. Receptacles shall not be placed back-to-back in adjacent rooms. They shall be offset at least 24" and installed with the grounding slot down.

C. Ground receptacle by attaching ground wire to device ground terminal. Use of receptacle mounting screws for receptacle grounding is not acceptable.

D. Contractor shall install GFCI outlets next to sinks per NEC.

E. Each receptacle shown with GFI protection shall be a separate GFI receptacle. Feed-through protection from upstream receptacles is not permitted.

F. On any system where more than one circuit is run through an outlet box with a single, duplex or combination receptacle, the receptacle shall be “pigtailed” and connected to its respective circuit with solderless connectors. Binding screws shall be used to attach the “pigtails”; push-in back wiring terminals shall not be used.

3.4 GROUNDING

A. Bond device ground terminals to raceway system per NEC.

END OF SECTION 16140

SECTION 16410 - DISCONNECTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fusible and non-fusible disconnecting devices.

1.2 SUBMITTALS

A. Product Data: Manufacturer’s literature.

1.3 QUALITY ASSURANCE

A. Devices shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with UL listing and the governing NEMA standards.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Product of Square D, Midwest, General Electric or Cutler-Hammer. Model, style, amp rating, NEMA type, etc., as scheduled or required.

2.2 SAFETY SWITCHES

A. Safety Switches – Fusible/Non-Fusible: Shall conform to NEMA Standard KSI-1975 for type HD (Heavy Duty.)

B. Switch Interior: All switches shall have switch blades which are fully visible in the OFF position when the door is open. Switches shall be of dead-front construction with permanently attached arc suppressors. Lugs shall be UL Listed for copper and/or aluminum cables and be front removable.

C. Switch Mechanism: Switches shall have a quick-make and quick-break operating handle and mechanism which shall be an integral part of the box, not the cover. Switches shall have a defeatable dual cover interlock to prevent unauthorized opening of the switch door in the ON position or closing of the switch mechanism with the door open. The switch shall be capable of being locked in the OFF position with one padlock.

D. Enclosures: Switch enclosure shall be suitable for the environment in which the switch is mounted. NEMA 1 enclosure shall be code gauge. UL-98, sheet steel, treated with a rust inhibiting phosphate and finished in gray, baked enamel. NEMA 3R enclosure shall conform to the same requirements as NEMA 1 except galvanized prior to painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install snap switch type disconnect at fractional horsepower motors where the equipment supplier has not provided a disconnecting means or is not specifically called out on the plan. Mount on equipment being served or adjacent to equipment within sight. Be cognizant not to mount on access doors or obstructing filter banks, etc.

B. Coordinate all details pertaining to size of motor and/or equipment, location, working clearances, and requirements to enclosure, ratings, etc., so as to provide the most suitable unit for the intended purpose. All exterior disconnects shall be weathertight and be provided with rain hubs.

C. Provide black laminated phenolic name plates engraved with name of equipment being disconnected. Where the rating of fused disconnect exceeds the ampacity of the conductors being protected, a permanent label noting maximum fuse size shall be installed in a conspicuous location within the switch.

D. Where recommended or required by the equipment manufacturer, or required by Underwriters Laboratories, disconnects shall be the fusible type, fused in accordance with the equipment nameplate information.

END OF SECTION 16410

SECTION 16420 - MOTOR STARTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manual and magnetic motor starters.

1.2 SUBMITTALS

A. Product Data: Manufacturer’s literature.

1.3 QUALITY ASSURANCE

A. Equipment shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with the governing NEMA standards. IEC type or rated equipment is not acceptable.

B. All devices shall include overloads appropriate for the application.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Product of Cerrus, General Electric. Equivalent Square D and Cutler-Hammer are acceptable.

B. As specified on the drawings.

2.2 AC MAGNETIC STARTERS – LINE VOLTAGE TYPE

A. Motor starters shall be magnetic soft-start type. Starters shall be mounted in NEMA 1 general purpose enclosures unless otherwise indicated on plans or required by the conditions of the area in which they are installed.

B. Starters shall be furnished with bimetallic type thermal overload relays in every phase conductor. Thermal units shall be of one-piece construction and interchangeable. Starters through NEMA size five (5) shall be equipped with double break silver alloy contacts. All contacts shall be replaceable without removing power wiring or removing starter from panel.

C. Coils shall be of molded construction, 120 VAC. Provide integral control transformers so that all pushbuttons, switches, lights, etc., operate at 120 Volts.

D. Starters shall be suitable for the addition of at least four (4) external electrical interlocks of any arrangement normally open or normally closed.

E. Each magnetic starter shall be provided with the following: Hand-off-auto switch, 2 N.O. and 2 N.C. contacts, control transformer fused on primary and secondary sides, red and green indicating lights.

F. All pilot lights must be high brightness LED type.

2.3 AC MANUAL STARTERS – LINE VOLTAGE TYPE

A. The manual starters shall consist of a manually operated switch equipped with bimetallic type thermal overload relays in every phase conductor. The overload relays shall be trip-free, and the starter shall be inoperative if any thermal unit is removed. Thermal units shall be one-piece construction.

B. Starters shall be furnished in a NEMA 1 general purpose enclosure unless otherwise indicated on the plans or required by the conditions of the area in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide a disconnect switch for each motor remotely located, adjacent to the motor, unless the motor is in sight of and within 50 ft. of its overcurrent device.

B. Provide liquid-tight flexible conduit connections to motor and other equipment subject to vibration. Minimum length 24 inches.

C. Set level, plumb, and firmly anchor to the structure adjacent motor being served. Do not mount on equipment access doors.

D. Provide and install correct heaters within the starters on all legs. Verify requirements from motor nameplate ratings or manufacturer's literature.

E. Identify all starters with black phenolic laminated nameplate. Engrave with name of equipment being served such as "EF-1".

F. Coordinate control transformer voltage with control Contractor.

G. Provide three-phase monitor protection in NEMA I enclosure adjacent to motor starter or within the motor starter enclosure when called for on drawings.

END OF SECTION 16420

SECTION 16490 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes overcurrent protective devices.

1.2 QUALITY ASSURANCE

A. Devices shall be the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with applicable standards and UL listings.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Breakers: Product of General Electric. Cutler-Hammer and Square D are acceptable.

B. Match the existing panel manufacturer and AIC rating for new circuit breakers installed in existing panels.

C. Fuses: Product of Bussmann, Littelfuse or Gould Shawmut.

2.2 MOLDED CASE CIRCUIT BREAKERS

A. Molded case circuit breakers shall be bolt-on type suitable for individual as well as panelboard mounting.

B. The breakers shall meet current NEMA and UL specifications as applicable to frame size, standard rating and interrupting capability. All breakers shall be made in the USA.

C. The breakers shall be one-, two-, or three-pole as scheduled, operate manually for normal ON-OFF switching and automatically under overload and short circuit conditions.

D. Operating handle shall open and close all poles simultaneously on a multi-pole breaker. Operating mechanism shall be trip-free so that contacts cannot be held closed against abnormal overcurrent or short circuit condition.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Size devices as shown and specified or as required by the load being served.

END OF SECTION 16490