Tomball ISD Chiller Package 1(b) -Tomball HS - Controls Upgrade
RFP #1002-6

Tomball High School
30330 Quinn Rd.
Tomball, TX, 77375

TOMBALL ISD
DESTINATION EXCELLENCE

PROJECT TEAM:

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BOARD OF TRUSTEES

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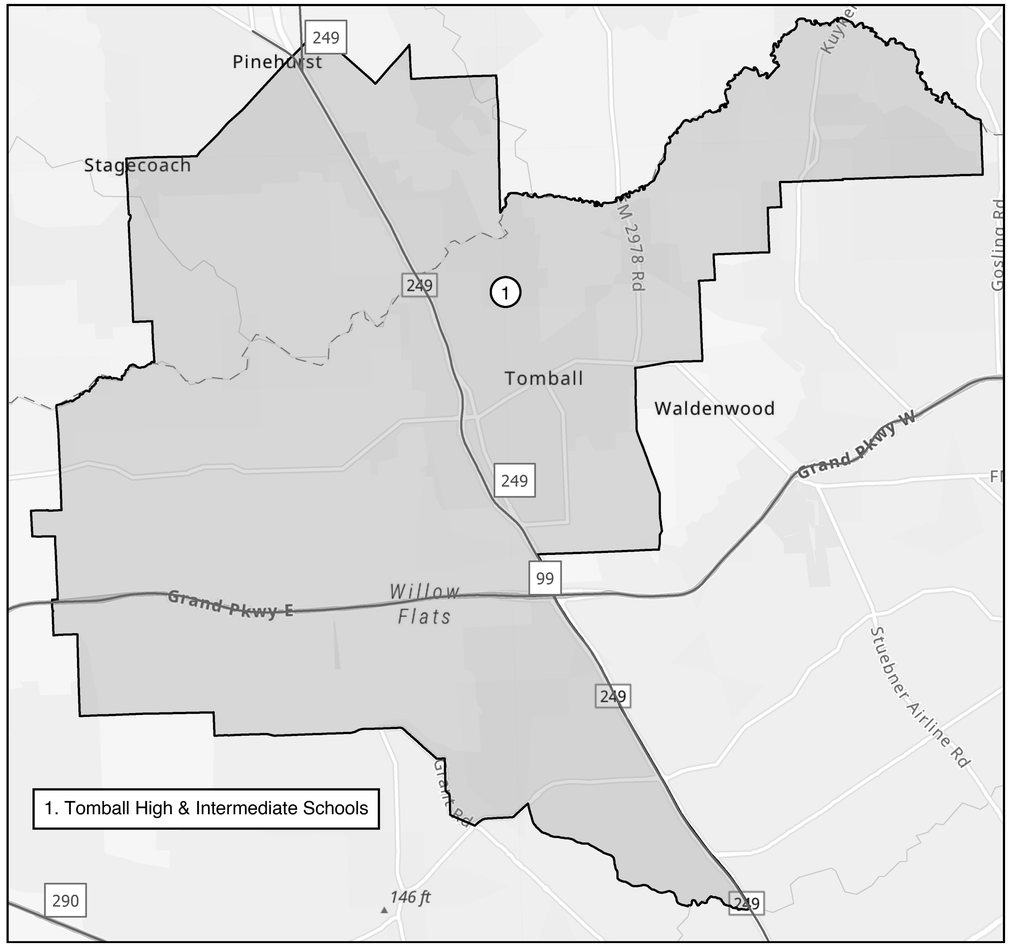
APPLICABLE CODES:

2021 INTERNATIONAL BUILDING CODE
2021 INTERNATIONAL MECHANICAL CODE
2021 INTERNATIONAL ENERGY CONSERVATION CODE
2023 NATIONAL ELECTRICAL CODE

PROJECT SHEET INDEX:

VICINITY MAP



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REVISION:

No.	DATE	DESCRIPTION
	05/29/2026	ISSUE FOR PROPOSAL

SEAL:

ADAM C. JONES
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LICENSED
PROFESSIONAL ENGINEER

Tomball ISD Chiller Package 1(b) -Tomball HS - Controls Upgrade

TBPE Firm Registration No. 2234

DATE: 05/29/2026

DRAWN BY: DBR

CHECKED BY: DBR

PROJECT NUMBER 260018.001

SHEET TITLE: COVER SHEET

SHEET NUMBER: 0.0

SECTION 00 01 10 - TABLE OF CONTENTS

SECTION 01 10 00 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 PROJECT DESCRIPTION

A. The Project, of which the work of this Contract is a part, is

Tombal ISD Chiller Upgrades - Tomball High School (1b).

B. Location: The site is located at 30330 Quinn Rd, Tomball, TX 77375.

C. The Project consists of:

1. DDC controls upgrades for Tomball High School but not limited to repalcement of end devices, revised controls sequencing, new control panels, and new controls graphics. Additional scope modication includes HVAC upgrades in the kitchen and cefeteria area and replacement of terminal units in 72 classrooms.

1.2 INSTRUCTIONS TO OFFERORS

A. No work on school test dates. All work shall be scheduled and coordinated with the owner. Chillers shall be replaced one at a time to maintain a level of cooling for the buidling during construction.

1.3 SALVAGED MATERIALS

A. Owner may salvage all items deemed reusable or necessary to keep from facilities to be demolished prior to the start of demolition.

B. Contractor shall remove and turn additional items over to the Owner, as directed.

C. Contractor shall demolish, remove and salvage all other items of demolished work.

1.4 CONTRACTS AND USE OF SITE

A. Contractor Use of Premises:

1. Confine operations at site to areas permitted by:

a. Law

b. Ordinances

c. Permits

d. Contract Documents

2. Do not unreasonably encumber site with materials or equipment.

3. Assume full responsibility for protection and safekeeping of products stored on premises.

4. Obtain and pay for use of additional storage or work areas as needed for operations.

5. Contractor shall establish secured staging area for work and coordinate and provide for safe passage and exit from building areas during construction, as determined by City and District officials.

6. Contractor shall coordinate all construction activities with Owner.

7. Owner reserves the right to perform construction operations with its own forces or to employ separate contractors on portions of the Project. Contractor shall coordinate with this work in terms of providing site access, work space, and storage space, cooperation of work forces, scheduling, and technical requirements.

8. Coordinate all utility shutdowns with Owner and, as required, with local utility companies, prior to commencement of shutdown.

B. Owner Occupancy:

1. Partial Owner Occupancy: The Owner reserves the right to place and install equipment in completed areas of the building, prior to Substantial Completion provided that such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.

2. A Certificate of Substantial Completion will be executed in accordance with conditions of the Contract.

3. Contractor shall obtain a Certificate of Occupancy from local building officials prior to Owner occupancy.

4. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy the Owner will provide operation and maintenance of mechanical and electrical systems in occupied portions of the building.

5. Prior to partial Owner occupancy, emergency and life safety systems shall be fully operational. Emergency and life safety systems include, but are not limited to, fire sprinkler systems, fire alarm systems, and emergency egress devices. For emergency exiting purposes, the path of travel shall be clearly delineated and functional. If required, temporary barricades shall separate on-going construction from occupied spaces as allowed by the governing agency holding jurisdiction over the Project. Required inspections and tests shall have been successfully completed. Upon occupancy the Owner will provide operation and maintenance of emergency and life safety systems in occupied portions of the building.

C. Owner-Furnished Items:

1. The Owner may provide items to the Contractor for installation in accordance with manufacturer’s recommendations and instructions.

2. The Owner will arrange and pay for delivery of Owner-furnished items in accordance with the Contractor's Construction Schedule, and will inspect deliveries for damage.

3. If Owner-furnished items are damaged, defective or missing, through no fault of the Contractor, the Owner will arrange for replacement.

4. The Contractor is responsible for designating the delivery dates of Owner-furnished items in the Contractor's Construction Schedule and for receiving, unloading and handling Owner-furnished items at the site. The Contractor is responsible for protecting Owner-furnished items from damage, including damage from exposure to elements, and to repair or replace items damaged as a result of his operations.

D. Coordination with Owner's Forces or Owner's Contractors:

1. Provide site access, space allocation, scheduling, scheduling coordination, coordination of work forces and coordination of technical requirements with the contractors that may be selected and employed by Owner to perform work simultaneously and in conjunction with the Work, which may include, but shall not be limited to the following, as applicable to the Project:

a. Materials Inspection and Testing Agency

b. HVAC Testing, Adjusting and Balancing Agency

c. Energy Management System Contractor

d. Data and Cabling System Contractor

e. Telephone System Contractor

f. Modular Furniture Installer

g. Lighting and Sound

h. Surveying

1.5 PROTECTION OF EXISTING PROPERTY

A. Contractor shall provide and maintain adequate protection of all Owner's existing property during duration of Project.

B. Contractor shall verify location of all existing underground pipelines on site with the owner of such pipelines and authorities having jurisdiction and shall provide and maintain adequate protection of all such pipelines during duration of project.

C. Protection of Trees:

1. Provide wood barricades around trees and shrubs at their drip line in traffic areas to protect them from construction operations until Substantial Completion, or until barricade removal is direct by Engineer.

1.6 USE OF ASBESTOS FREE MATERIALS, PRODUCTS AND SYSTEMS

A. The Contractor is reminded to refer to front end documents for requirements regarding asbestos containing materials (ACM).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to Specification Sections.

PART 3 - EXECUTION

3.1 CONSTRUCTION SCHEDULE

A. Completion Time: Refer to front end for Schedule of events for construction timeline.

B. Proposers shall structure their pricing and proposal as required to meet the designated schedule.

C. Submission of a proposal for consideration shall be construed as proposer’s agreement to meet the stipulated schedule without qualification or exclusion.

END OF SECTION

SECTION 01 21 00 - ALLOWANCES

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The following Allowances shall be included in the Base Proposal. These sums shall be reconciled per Article 3.8 of the General Conditions.

1.2 CONDITIONS

A. The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents.

B. These allowances shall cover the net cost of the materials and equipment delivered and unloaded at the site and cost of installation where applicable.

1. Use of Owner Contingency shall be solely at the discretion of the Owner, and the Contractor shall expend funds for the purpose and amounts as directed by the Owner.

C. The Contractor's handling costs on site, labor, installation, overhead, profit and other expenses contemplated for the original allowance shall be included in the Contractor's Base Proposal sum, and not in the allowance.

D. The Contractor shall cause the work covered by these allowances to be performed for such amounts and by such persons as the Engineer may direct, but he will not be required to employ persons against whom he makes reasonable objection.

E. If the cost, when determined, is more than or less than the allowance, the Contract sum shall be adjusted accordingly by Change Order, which will include additional handling costs on the site, labor, installation costs, overhead, profit and other expenses resulting to the Contractor from any increase over the original allowance.

1. All labor, equipment and installation required for the installation and / or performance of the designated work shall be included in the allowance amount, unless noted otherwise in the Allowance description.

F. Unexpended balance of allowance sums shall revert to the Owner in the final settlement Change Order of the Contract.

PART 2 - ALLOWANCES

2.1 ITEMS

A. Owner Contingency:

1. Contractor shall include in the Base Proposal the following sums as a contingency to cover the cost of hidden, concealed or otherwise unforeseen conditions which develop during completion of the work. Contractor shall proceed with the work in question only after receiving written directions executed by the Owner and the Engineer. Owner will not be obligated to pay the cost of any work performed without prior written authorization. The Contractor's overhead and profit relative to this contingency sum and work performed in accordance herewith, shall be included in the total Base Proposal price, but not included in the contingency sum. Unexpended balance of contingency sums shall revert to the Owner in the final settlement of the Contract.

   Allow the sum of $330,000.00 for Owner's Contingency..... $330,000.00

END OF SECTION

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 ALTERNATE PRICES

A. Contractor shall state, in the spaces provided in the Proposal Form, alternate prices for the work described in the Alternate.

1. Proposer's pricing for Alternates shall be the net change to the Base Proposal amount to include the cost of all supporting elements required to implement the described Alternate scope of work.

2. Work for all Alternates shall be in strict accordance with the Specification and applicable work as indicated on the Drawings.

B. Unless otherwise indicated, scope of work for each alternate shall include material and labor, general conditions and all other costs, as applicable, associated with completing the work described.

C. Alternates are not listed in the order of priority.

D. Acceptance of Alternates and inclusion in the Owner-Contractor Agreement shall be at the sole discretion of the Owner.

1. Proposed pricing of Alternate Proposals shall be such that no matter what combination of Base Proposal and Alternates are accepted, the corresponding Contract amount shall be the total sum required to provide the full and defined scope of work.

PART 2 – DESCRIPTION OF ALTERNATE PROPOSALS

2.1 ALTERNATE NO. 1 – CHILLERS

A. Alternate 1: Kitchen/Cafe/Commons - HVAC Renovation

Provide pricing for new RTUs and AHU as scheduled, including all associated hydronic piping, ductwork, controls, electrical modifications, accessories, demolition, installation, and all other work required for a complete and operational system. Provide lead time for AHU or RTUs on bid form, only noting the longest lead time.

B. Alternate 2: Fan Powered Terminal Unit Replacement

Provide pricing for replacement of CVBs with new Fan Powered Terminal Units with hydronic hot water heating as scheduled, including all associated hydronic piping, ductwork modifications, controls, electrical modifications, accessories, demolition, installation, and all other work required for a complete and operational system. Provide lead time of FPTs on bid form.

END OF SECTION

SECTION 01 25 13 - PRODUCTS AND SUBSITUITIONS

PART 1 - GENERAL

1.1 DESCRIPTION OF REQUIREMENTS:

A. DEFINITIONS: Definitions used in this Section are not intended to negate the meaning of other terms used in the Contract Documents, including such terms as, "specialties", "systems", "structure", "finishes", "accessories", "furnishings", "special construction" and similar terms. Such terms are self-explanatory and have recognized meanings in the construction industry.

B. "Products" are items purchased for incorporation in the Work, regardless of whether they were specifically purchased for the project or taken from the Contractor's previously purchased stock. The term "product" as used herein includes the terms "material", "equipment", "system" and other terms of similar intent.

C. The Contract is based on the products, materials, and equipment described in the Contract Documents, and added by Addenda.

D. AVAILABILITY OF SPECIFIED ITEMS: Verify prior to bidding that all specified items will be available in time for installation during orderly and timely progress of the Work.

1. In the event specified items or items will not be so available, notify the Engineer at least 10 days prior to receipt of Bids.

2. Additional costs due to delays because of non-availability of specified items, when such delays could have been avoided, will be back-charged to the Contractor and shall not be borne by the Owner.

E. Where the questions of appearance, artistic effect, or harmony of design are concerned, the Engineer reserves the right to refuse approval of any product proposed to be substituted for that specified if in his opinion the item to be substituted is not harmonious to the finished effect and appearance desired, as portrayed in the Drawings and Specifications. The Engineer's said refusal to approve, established by this Article, is final.

1.2 SUBSTITUTIONS:

A. The Contractor's requests for changes in the products, materials, equipment and methods of construction required by the Contract Documents are considered requests for "substitutions", and are subject to the requirements specified herein. The following are not considered as substitutions:

1. Revisions to the Contract Documents, where requested by the Owner, Engineer are considered as "changes" not substitutions.

2. Substitutions requested during the bidding period, which have been accepted prior to the Contract Date, are included in the Contract Documents and are not subject to the requirements for substitutions a herein specified.

3. Specified Contractor options on products and construction methods included in the Contract Documents are choices available to the Contractor and are not subject to the requirements for substitutions as herein specified.

4. Except as otherwise provided in the Contract Documents, the Contractor's determination of and compliance with governing regulations and orders as issued by governing authorities do not constitute "substitutions" and do not constitute a basis for change orders.

1.3 QUALITY ASSURANCE

A. SOURCE LIMITATIONS: To the fullest extent possible, provide products of the same generic kind, from a single source, for each unit of work.

1. COMPATIBILITY OF OPTIONS: Compatibility of products is a basic requirement of product selection. When the Contractor is given the option of selecting between two or more products for use on the project, the product selected must be compatible with other products previously selected, even if the products previously selected were also Contractor options. The complete compatibility between the various choices available to the Contractor is not assured by the various requirements of the Contract documents, but must be provided by the Contractor.

1.4 SUBMITTALS

A. PRODUCT LISTING SUBMITTAL: Prepare a product-listing schedule in a form acceptable to the Engineer. Show names of the principal products required for the work, by generic name. Show proprietary product names and the name of the manufacturer for each item listed that is to be purchased and incorporated into the Work.

1. Refer to Division 26 General Provisions sections for a special separate listing of products required for mechanical and electrical Work.

2. FORM: Prepare the product-listing schedule with information on each item tabulated under the following scheduled column headings:

a. Generic name as used in Contract Documents.

b. Proprietary name, model number and similar product designation.

c. Manufacturer's and supplier's name and city/state addresses.

d. Related unit-of-work specification section number.

3. SUBMITTAL: Submit 3 copies of the product-listing schedule within 30 days after the date of commencement of the Work. Provide a written explanation for omissions of data, and for known variations from contract requirements.

a. At the Contractor's option, the initial submittal of the product-listing schedule may be limited to product selections and product designations that must be established early in the Contract Time.

Submit the completed product-listing schedule within 60 days after commencement of the Work.

4. ENGINEER'S ACTION: The Engineer will respond to the Contractor in writing within 2 weeks of receipt of the product-listing schedule. No response by the Engineer within the 2 week time period constitutes no objection to the listed products or manufacturers, but does not constitute a waiver of the requirement that products comply with the requirements of the contract documents. The Engineer's response will include the following:

   a. The Engineer's listing of unacceptable product selections, if any, containing an explanation of the reasons for this action.

   b. A request for additional data necessary for the review and possible acceptance of the products and manufacturer's listed.

B. SUBSTITUTION REQUEST SUBMITTAL: Submit 3 copies of each request for substitution. In each request identify the product, fabrication, and installation method to be replaced by the substitution; include related Specification Section and Drawing numbers, and complete documentation showing compliance with the requirements for substitutions. Include the following information, as appropriate, with each request.

   1. Provide complete product data, drawings and descriptions of products, and fabrication and installation procedures.

   2. Provide samples where applicable or requested.

   3. Provide a detailed comparison of the significant qualities of the proposed substitution with those of the work originally specified. Significant qualities include elements such as size, weight, durability, performance and visual effect where applicable.

   4. Provide complete coordination information. Include all changes required in other elements of the work to accommodate the substitution, including work performed by the Owner and separate Contractors.

   5. Provide a statement indicating the effect the substitution will have on the work schedule in comparison to the schedule without approval of the proposed substitution. Include information regarding the effect of the proposed substitution on the Contract Time.

   6. Provide complete cost information, including a proposal of the net change, if any in the contract Sum.

   7. Provide certification by the manufacturer to the effect that the proposed substitution is suitable for the application as further defined in Article 2.02 herein.

   8. Provide certification by the Contractor to the effect that, in the Contractor's opinion, after thorough evaluation, the proposed substitution will result in work that in every significant respect is equal-to or better than the work required by the Contract documents, and that is will perform adequately in the application indicated.

a. Include in this certification, the Contractor's waiver of rights to additional payment or time, which may subsequently be necessary because of the failure of the substitution to perform adequately.

9. ENGINEER'S ACTION: As soon as possible after receipt of the Contractor's request for substitution, the Engineer will notify the contractor of either the acceptance or rejection of the proposed substitution. Acceptance of substitute products will be contingent upon submission of substantiating data, satisfactory to the Engineer, that:

a. Item is equal to quality and serviceability to specified product.

b. Use of item will not entail changes in details and construction of related work.

c. Item conforms to required design and artistic effect.

d. There will be a cost advantage to the Owner.

10. The burden of proof shall be upon the Contractor.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. GENERAL: Deliver, store, and handle products in accordance with manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft. Control delivery schedules to minimize long-term storage at the site and to prevent overcrowding of construction spaces. In particular coordinate delivery and installation to ensure minimum holding or storage times for items known or recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other sources of loss.

1. Deliver products to the site in the manufacturer's sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting and installing.

2. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.

3. Store heavy materials away from the project structure in a manner that will not endanger the supporting construction.

4. Containers which are broken, opened, watermarked, or otherwise damaged, and which contain caked, lumpy or otherwise damaged materials are unacceptable and shall be immediately removed from the premises.

5. Store all cement, lime, plaster, aggregates, roofing materials, and similar items above ground and protected from dampness, weather and other damage.

6. Retain all loose and small detachable parts of apparatus and equipment until the completion of the Work. Turn over to Owner or his representative designated to receive them, and obtain from him an itemized receipt thereof in triplicate. Retain one copy of this receipt for final payment for the Work.

B. Contractor shall ensure that products are delivered to the Project in accordance with the Progress Schedule of the Project. In determining date of delivery, sufficient time shall be allowed for submittal approvals, including the possibility of having to resubmit improperly prepared submittals or products other than those specified, and the necessary fabrication or procurement time along with the delivery method and distance involved.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT COMPLIANCE

A. GENERAL: Requirements for individual products are indicated in the Contract Documents; compliance with these requirements is in itself a contract requirement. These requirements may be specified in any one of several different specifying methods, or in any combination of these methods. These methods include the following:

1. Proprietary.

2. Descriptive.

3. Performance.

4. Compliance with Reference Standards.

B. PROCEDURES FOR SELECTING PRODUCTS: The Contractor's options in selecting products are limited by requirements for the Contract Documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects. Required procedures include but are not limited to the following for the various indicated methods of specifying:

1. PROPRIETARY AND SEMIPROPRIETARY SPECIFICATION REQUIREMENTS:

a. SINGLE PRODUCT NAME: Where only a single product or manufacturer is named, provide the product indicated, unless the specification indicates consideration of other products. Advise the Engineer before proceeding, when it is discovered that the named product is not a reasonable or a feasible solution.

b. TWO OR MORE PRODUCT NAMES: Where two or more products or manufacturers are named, provide one of the products named, at the Contractor's option. Do not provide or offer to provide an unnamed product, unless the specification indicates consideration of other products. Advise the Engineer before proceeding where none of the named products comply with specification requirements, or are feasible for use.

c. Where products or manufacturers are specified by name, accompanied by the term "or-equal" or similar language, comply with the contract document provisions concerning "substitutions" to obtain approval from the Engineer for the use of an unnamed product.

2. DESCRIPTIVE SPECIFICATION REQUIREMENTS: Where the specifications describe a product or assembly generically, in detail, listing the exact characteristics required, but without use of a brand or trade name, provide products or assemblies that provide the characteristics indicated and otherwise comply with contract requirements.

3. PERFORMANCE SPECIFICATION REQUIREMENTS: Where the specifications require compliance with indicated performance requirements, provide products that comply with the specific performance requirements indicated, and that are recommended by the manufacturer for the application indicated. The manufacturer's recommendations may be contained in published product literature, or by the manufacturer's individual certification of performance. General overall performance of a product is implied where the product is specified for specific performances.

4. COMPLIANCE WITH STANDARDS, CODES AND REGULATIONS: Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including the standards, codes and regulations.

5. VISUAL MATCHING: Where matching an established sample is required, the final judgment of whether a product proposed by the Contractor matches the sample satisfactorily will be determined by the Engineer. Where there is no product available within the specified product category that matches the sample satisfactorily and also complies with other specified requirements, comply with the provisions of the contract documents concerning "substitutions" and "change orders" for the selection of a matching product in another product category, or for non-compliance with specified requirements.

6. VISUAL SELECTION: Except as otherwise indicated, where specified product requirements include the phrase "...as selected from the manufacturer's standard colors, patterns, textures..." or similar phrases, the Contractor has the option of selecting the product and manufacturer, provided the selection complies with other specified requirements. The Engineer is subsequently responsible for selecting the color, pattern and texture from the product line selected by the Contractor.

C. For each product specifically specified or as requested by Engineer, submit a written certified statement from the manufacturer of each specified, or accepted substitute, product, material, and equipment item warranting that each product, material, and item of equipment furnished by him and installed in this Project is suitable for the application shown and specified in the Contract Documents, and includes all features, accessories, and performing characteristics listed in the manufacturer's catalog in force on the date bids are requested for the Work. This warranty is intended as a assurance by the manufacturer that his material or equipment is not being misapplied and is fit and sufficient for the service intended. This warranty is in addition to and not in limitation of any other warranty or remedy required by law of by the Contract Documents. It shall be the responsibility of the Contractor to obtain this warranty in writing.

2.2 SUBSTITUTIONS

A. With each request for substitution, submit written certified statement from the manufacturer of the substitute warranting that each product, material, and item of equipment is equal to or better than the specified product in all respects and is suitable for application on this specific project.

B. CONDITIONS: The Contractor's request for a substitution will be received and considered when extensive revisions to the contract documents are not required, when the proposed changes are in keeping with the general intent of the contract documents, when the requests are timely, fully documented and properly submitted, and when one or more of the following conditions is satisfied, all as judged by the Engineer; otherwise the requests will be returned without action except to record non-compliance with these requirements.

1. The Engineer will consider a request for substitution where the request is directly related to an "or equal" clause or similar language in the Contract Documents.

2. The Engineer will consider a request for substitution where the specified product or method cannot be provided within the Contract Time. However, the request will not be considered if the product or method cannot be provided as a result of the Contractor's failure to pursue the work promptly or to coordinate the various activities properly.

3. The Engineer will consider a request for substitution where the specified product or method cannot receive necessary approval by a governing authority, and the requested substitution can be approved.

4. The Engineer will consider a request for a substitution where a substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. These additional responsibilities may include such considerations as additional compensation to the Engineer for redesign and evaluation services, the increased cost of other work by the Owner or separate contractors, and similar considerations.

5. The Engineer will consider a request for substitution when the specified product or method cannot be properly coordinated with other materials in the work, and where the Contractor certifies that the proposed substitution can be properly coordinated.

2.3 GENERAL PRODUCT REQUIREMENTS

A. GENERAL: Provide products that comply with the requirements of the Contract Documents and that are undamaged and, unless otherwise indicated, unused at the time of installation. Provide products that are complete with all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.

1. STANDARD PRODUCTS: Where they are available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

2. CONTINUED AVAILABILITY: Where, because of the nature of its application, the Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, provide standard products for which the manufacturer has published assurances that the products and its parts are likely to be available to the Owner at a later date.

B. Except for code required labels, equipment nameplate data or other similar labels containing manufacturer's name, address, model number, capacity, and other rating information securely attached to each piece of equipment, the installation of any item, element or assembly, which bears on any exposed surface any name, trademark or other insignia which is intended to identify the manufacturer, the vendor, or other sources from which such object has been obtained, is prohibited. Also forbidden is the installation of any article which bears visible evidence that a name, trademark, or other insignia has been removed.

1. CODE REQUIRED LABELS: Locate required product labels and stamps on a concealed surface or, where required for observation after installation, on an accessible surface which, in occupied spaces, is not conspicuous.

2. EQUIPMENT NAMEPLATES: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate the nameplate on an easily accessible surface which is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data.

a. Name of manufacturer.

b. Name of product.

c. Model number.

d. Serial number.

e. Capacity.

f. Speed.

g. Ratings.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

A. All manufactured products shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the manufacturer's printed directions, unless herein specified to the contrary. Where manufacturer's printed directions are available and where reference is made to manufacturer's directions in the specifications, the Contractor shall submit copies of such directions to the Engineer in accordance with the requirements of Section 01300 prior to the beginning of any work covered thereby.

B. Where specific installation instructions are not part of these Specifications and Drawings, all products, materials, and equipment shall be installed in strict accordance with instructions from the respective manufacturer. Where installation instructions included in these Specifications or Drawings are at a variance with instructions furnished by the manufacturer, the Contractor shall make written request for clarification from the Engineer.

C. In accepting or assenting to the use of any apparatus or material, or make or arrangement thereof, the Engineer in no way waives any of the requirements of these Specifications or the warranty embodied therein.

3.2 ACCEPTANCE OF EQUIPMENT OR SYSTEMS

A. The Owner will not accept the start of the warranty period on systems or equipment until Substantial Completion is issued for Owner's occupancy of the building, in part or whole. Contractor shall make such provisions as required to extend the manufacturer's warranty from time of initial operation of systems or equipment until Substantial Completion is given in writing.

END OF SECTION

SECTION 01 29 73 - SCHEDULE OF VALUES

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide a detailed breakdown of the agreed Contract Sum showing values allocated to each of the various parts of the work, as specified herein and in other provisions of the Contract Documents.

B. Provide seperate detailed detailed breakdown of the agreed Contract Sum showing values for the 2 campuses (Decker Prairie & Admin. Bldg)

C. Related Work

1. Documents affecting work of this section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

1.2 QUALITY ASSURANCE

A. Use required means to assure arithmetical accuracy of the sums described. When so required by the Engineer, provide copies of the subcontracts or other data acceptable to the Engineer, substantiating the sums described.

B. The Schedule of Values shall be broken down into costs for each specification section as labor and materials at a minimum.

1. The contractor is encouraged to make the schedule of values very detailed in order to facilitate review and approval of requested percentages complete on pay applications.

2. Where breakdown is vague, or includes multiple / combined assemblies, stages, tasks, etc., Engineer’s review shall be conservative in favor of the Owner regarding approval of Pay Applications.

1.3 APPLICATION FOR PAYMENT SCHEDULE OF VALUES

A. The schedule of values, once approved shall be transferred to columns B and C of AIA G702/G703 – Application for Payment to be used for all progress payments.

B. Once AIA G702/G703 – Application for Payment has been submitted for payment, individual line item amounts in column C must remain unchanged throughout the progress of the work.

C. In the beginning stages of the construction, total amounts for entire divisions may be used if complete breakdowns are not available; and shall be line item populated as soon as practical.

D. No payments will be approved in divisions that do not have a line item breakdown.

E. Allowances shall be shown, and remain throughout construction, as a single line item on the master application for payment in amount(s) as stipulated in the Contract Documents.

F. For each Allowance, expenditures and accounting shall be included on a separate, attached spread sheet of the same format as the master application for payment.

G. The master application for payment shall reflect only the summary of each allowance; and shall not contain individual allowance activity(s).

1.4 SUBMITTALS

A. Prior to the first Application for Payment, submit a proposed schedule of values to the Engineer, as outlined below.

B. Meet with the Engineer and determine additional data, if any, is required to be submitted.

C. Secure the Engineer's approval of the schedule of values prior to submitting the first Application for Payment.

PART 2 - PRODUCTS

2.1 SCHEDULE OF VALUES

A. Schedule of values for division 2 through 32 shall be broken down for each separate section of work, and include multiple items covered where appropriate.

1. Each item of work shall be broken down by material and labor at a minimum.

2. Where payment for shop drawings, submittals, record drawings and similar are expected, the items must be included as a separate item on the schedule of values.

END OF SECTION

SECTION 01 31 13 - PROJECT COORDINATION

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies administrative and procedural requirements necessary for coordinating Work operations including, but not limited to, the following:

1. General coordination procedures.

2. Sequential work of trades.

B. Related Work:

1. Section 01 32 16 – Construction Progress Schedule

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 – EXECUTION

3.1 COORDINATION - GENERAL

A. Contractor shall coordinate operations included in various sections of Contract Documents to assure efficient and orderly installation of each part of Work. Coordinate Work operations included under related sections of Contract Documents that depend on each other for proper installation, connection, and operation of Work, including but not limited to:

1. Schedule construction operations in sequence required where installation of one part of 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. Provide provisions to accommodate items scheduled for later installation.

4. Prepare and administer provisions for coordination drawings.

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

1. Preparation of schedules.

2. Installation, relocation, and removal of temporary facilities.

3. Delivery and processing of submittals.

4. Progress meetings.

5. Project closeout activities.

C. Contractor will be responsible for the overall coordination review. As each coordination drawing is completed, Contractor will meet with Engineer and Owner to review and resolve all conflicts on coordination drawings.

D. The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of shop drawings, product data, samples or similar submittals until the respective submittal has been reviewed by the Engineer / Consultant without request for re-submittal.

END OF SECTION

SECTION 01 31 19 - PROJECT MEETINGS

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Refer to Section AB – Instructions to Proposers and Section AF – Manufacturer Prequalification for substitutions.

B. Scope of Work:

1. Contractor participation in preconstruction conference.

2. Contractor administration of pre-installation conferences.

3. Contractor administration of progress meetings

1.2 PRECONSTRUCTION CONFERENCE

A. Engineer will administer preconstruction conference for execution of Owner-Contractor Agreement, and exchange preliminary submittals.

B. Engineer will administer site mobilization conference at project site for clarification of Owner and Contractor responsibilities, in use of site and for review of administration procedures.

1.3 PRE-INSTALLATION CONFERENCES

A. Contractor shall convene pre-installation conferences with each sub-contractor prior to commencing work of the sub-contractor.

1. Contractor shall record attendance on a sign-in sheet.

2. Contractor shall keep minutes of the conference and distribute to all attending parties prior to the start of the work.

B. The purpose of the meeting is to fully review subcontractor’s work to assure initial installation will be in accordance with the Contract Documents. The agenda shall include, but not necessarily limited to the following:

1. Review the contract documents, including any changes thereto.

2. Review all RFI’s that may affect the work.

3. Review the final reviewed submittals, including AE and Contractor comments.

4. Review conditions of installation, preparation and installation procedures.

5. Review coordination with related / interfacing work.

6. It is the responsibility of the contractor / sub-contractor to resolve all unknown issues, unclear issues, coordination issues, and assembly interface issues in order to comply with the requirements of the Contract Documents.

C. Require attendance includes, but is not limited to the following:

1. Contractor’s superintendent

2. Engineer’s field representative

3. Relative sub-contractor

4. Sub-contractors providing adjacent and / or interfacing work.

5. Other sub-contractors whose work may be affected by the relative sub-contractor.

D. Pre-installation conferences shall be scheduled a minimum of 48 hours in advance of the start of relative work unless otherwise agreed to by all parties.

E. Pre-installation conferences may be scheduled with multiple sub-contractors at the same time to facilitate awareness of related work. Coordinate with Engineer’s field rep.

F. The contractor shall keep meeting minutes and distribute to all attendees within three days after the meeting; or sooner if required to facilitate project scheduling.

1.4 PROGRESS MEETINGS

A. Contractor shall schedule and administer all project meetings after mobilization conference throughout progress of the work at weekly intervals, plus any special called meetings, and all pre-installation conferences.

B. Contractor shall make physical arrangements for meetings, preside at meetings, record minutes, and distribute copies of minutes within two days to attendees, and those affected by decisions made at meetings.

C. Required Attendance:

1. Contractor’s Superintendent

2. Contractor’s Project Manager

3. Engineer’s Project Manager

4. Engineer’s Field Representative

5. Engineer’s Consultants as appropriate to agenda topics for each meeting.

6. Owner’s Representative.

D. The primary purpose of the weekly progress meetings is to update the Owner of the project status, progress, schedule and outstanding issues. It shall not be a venue for resolving issues that can otherwise be resolved between the Contractor and Engineer / consultants; unless direct input from the Owner is required.

1. In as much as practical, meetings shall be scheduled on the same day and time each week. Changes in the normal schedule must be agreed to by all parties.

E. Suggested Agenda:

1. Review work completed since the previous meeting.
2. Review status of progress schedule and adjustments thereto, and delivery schedules.
3. Review submittal log,
4. Review change proposal log, minor changes and other adjustments to the Work
5. Review pending changes and substitutions.
6. Review AE construction observation reports and resolutions to outstanding issues
7. Review as-built documents and close-out progress,
8. Discuss other items affecting progress of work.
9. New business

1.5 PROGRESS MEETING MINUTES

A. Progress meeting minutes shall be furnished by the Contractor and shall be structured to identify all discussion topics and action items by the initiating meeting and the eventual outcome.

B. Each meeting with unresolved information or pending action items shall remain on the meeting minutes, in the above format, through one meeting beyond resolution or completion of the pending action of the item, where the item can be reviewed one more time and ALL parties agree the item can be removed from the meeting minutes.

C. The last meeting shown on the meeting minutes shall relate to the most recent meeting held and shall include ALL topics of discussion at that meeting.

D. Up-to-date meeting minutes shall be furnished to all attendees at the beginning of each meeting.

E. This sample is created in Excel and an electronic copy shall be furnished to the contractor upon request.

END OF SECTION

SECTION 01 32 16 - CONSTRUCTION SCHEDULE

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Schedules:

1. Preliminary Analysis: Within 7 (seven) days after receipt of Notice to Proceed, submit a preliminary construction schedule for review.

2. Construction Schedule: Within 14 (fourteen) days after receipt of Notice to Proceed, submit one (1) reproducible.

1.2 RELIANCE UPON SCHEDULE

A. The construction schedule as approved by the Engineer will be an integral part of the Contract, and will establish conditions for various activities and phases of construction.

1.3 CONSTRUCTION SCHEDULE

A. Diagram: Graphically show the order of all activities necessary to complete the work and the sequence in which each activity is to be accomplished.

B. Activities shown on the diagram shall include, but not necessarily be limited to:

1. Project mobilization.

2. Submittals and approvals of shop drawings and samples.

3. Phasing of construction.

4. Procurement of equipment and critical materials.

5. Fabrication and installation of special material and equipment.

6. Final clean-up.

7. Final inspection and testing.

C. Contractor shall follow and include the critical dates, as indicated in the front end documents, in the construction schedule. There shall be no deviations from these critical dates unless authorized by Owner/Engineer.

1.4 CONSTRUCTION SCHEDULE LIMITATIONS

A. Work performed under this Contract shall be performed in accordance with the following paragraphs:

1. All work may proceed immediately upon Construction Start Date and continue as coordinated with owner.

2. The Owner has a critical need for all submittals to be ready for review upon Notice to Proceed and the work to begin on Construction Start Date and be Substantially Complete by the substantial completion date.

3. Under the Base Proposal only, the successful Offeror will be 1) entitled to certain extensions of time and 2) subject to liquidated damages for work not completed beyond the agreed date which the Contractor shall required for Substantial Completion of the work included in this contract. Refer to Supplementary Conditions for additional requirements and liquidated damages.

4. Failure to complete and close-out project after substantial completion may result in liquidated damages. Refer to Supplementary Conditions for additional requirements and liquidated damages.

5. The Owner may at his discretion approve changes recommended by the successful Offeror to the above-mentioned schedule provided that the Owner's use of newly completed areas are not disrupted.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 33 00 - SUBMITTAL PROCEDURES

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION OF WORK OF THIS SECTION

A. Work of this Section includes procedural requirements for submittals including but not limited to the following items:

1. ADMINISTRATIVE SUBMITTALS INCLUDING:

a. Listing of subcontractors.

b. Insurance certificates.

c. Schedule of Values.

d. Performance and Payment Bonds.

e. Construction Progress Schedule.

f. Inspection and test reports.

g. Payment applications.

h. Submittal Schedule.

i. Product Listing Schedule.

j. Project meeting minutes.

2. SHOP DRAWINGS, INCLUDING:

a. Fabrication and installation drawings.

b. Patterns.

c. Schedules.

3. PRODUCT DATA, INCLUDING:

a. Manufacturer's product specifications and installation instructions.

b. Standard color charts.

c. Catalog cuts.

d. Roughing-in diagram and templates.

e. Standard wiring diagrams.

f. Standard product operating and maintenance manuals.

g. Manufacturer's product certifications for specified products and as requested by Engineer, and as specified (refer to Section 01600).

4. MISCELLANEOUS SUBMITTALS, INCLUDING:

a. Field measurement data.

b. Survey data and reports.

c. Testing and certification reports.

5. CLOSEOUT SUBMITTALS: Refer to Section 01700 for additional requirements.

a. Specially-prepared and standard printed warranties.

b. Maintenance agreements.

c. c. Workmanship bonds.

d. Record drawings.

e. Operating and maintenance manuals.

f. Keys and other security protection devices.

g. Maintenance tools and spare parts.

h. Overrun stock.

PART 2 - PRODUCTS

2.1 SHOP DRAWINGS

A. SPECIAL SUBMITTAL REQUIREMENTS:

1. OWNER REVIEW OF SHOP DRAWINGS: Owner review will be in addition to Engineer's review. Submit Shop Drawings promptly and allow additional time for the additional review.

2. Schedule of Values.

3. Construction Progress Schedule.

4. Record Drawings: Refer to Section 01700.

B. SUBMITTAL PREPARATION: Mark each submittal with a permanent label or title block, as appropriate, for identification with the following information on the label or title block for proper processing and recording of action taken.

1. Title of submittal and date submitted.

2. Sheet number and number of sheets included (as applicable). Number drawings consecutively.

3. Name and location of Project.

4. Name of Engineer and Engineer's Job Number.

5. Name of Contractor, subcontractor, fabrication supplier, and manufacturer, as appropriate.

6. Name of drawing and scale (as applicable).

7. Name and date of each revision.

8. Cross reference to Engineer's Drawings and Specification Section, as appropriate.

9. Provide a space on the label or adjacent to title block for the Contractor's review and approval markings, and appropriate space for the Engineer's "Action" stamp.

10. Number each submitted transmittal sequentially and individually.

11. Contractor's stamp shall provide Project name, date of Contractor review, and number of submittal.

C. SUBMITTAL TRANSMITTAL: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the Contractor to the Engineer, and to other destinations as indicated, by use of a transmittal form. Contractor shall be responsible for delivery and pick-up of all submittals. Submittals received from sources other than the Contractor will be returned to the sender "without action". Use a transmittal form with places for the following information:

1. Project name.

2. Date.

3. To:

4. From:

5. Names of subcontractor, manufacturer and supplier.

6. References.

7. Category and type of submittal.

8. Submittal purpose and description.

9. Submittal and transmittal distribution record.

10. Signature of transmitter.

11. Contractor's certification stating that the information submitted complies with the requirements of the Contract Documents, with a place for the Contractor's signature.

12. Record relevant information and requests for data on the transmittal form. On the transmittal form, or on a separate sheet attached to the form, record deviations from the requirements of the Contract Documents, if any, including minor variations and limitations.

2.2 SPECIFIC SUBMITTAL REQUIREMENTS:

A. GENERAL: Specific submittal requirements for individual units of work are specified in the applicable Specification Section. Except as otherwise indicated in the individual Specification Sections, comply with the requirements specified herein for each type of submittal.

1. Refer to Section 01600 for additional submittal requirements relating to the Product Listing Schedule and Substitution Requests.

B. CONSTRUCTION PROGRESS SCHEDULE: Upon award of the Contract, the Contractor shall consult with the Engineer and Owner regarding the order in which the Work is to be performed and shall prepare a Construction Progress Schedule for the Owner's and Engineer's review. This Schedule shall be in a form approved by Engineer and Owner, and shall show a sequence of operations mutually agreeable to all parties concerned, including the work in connection with or affecting the use of streets, services, and utilities, based on final completion of all Work on or before the completion date stated in the Contract. Revise regularly as required. Schedule early completion of designated areas for Owner's usage prior to Substantial Completion of entire Project.

C. SCHEDULE OF VALUES:

1. Submit Schedule of Values to Engineer for approval.

a. Upon request by Engineer support values given with data that will substantiate their correctness.

b. Submit quantities of designated materials.

c. Use Schedule of Values only as basis for Contractor's Application for Payment.

1) Submit updated Schedule of Values with each Application for Payment.

2. Submit typewritten Schedule of Values on AIA Document G703 Continuation Sheet.

a. Use Specification Table of contents as basis of format for listing costs of Work for Sections under Divisions 2 through 16.

b. Identify each line item with number and title as listed in Specification Table of Contents.

3. Itemize separate line item cost for each of the following cost items:

a. Performance and Payment Bonds.

b. Field supervision and layout.

c. Temporary facilities and controls.

4. Itemize separate line item cost for work required by each Section of the Specifications.

5. Round off figures to nearest ten dollars.

6. Make sum of total costs of all items listed in Schedule equal to total Contract Sum.

7. After review by Engineer, revise and resubmit Schedule of Values as required.

8. Resubmit revised Schedule(s) in same manner.

PART 3 – EXECUTION

3.1 REVIEW PROCEDURE

A. Upon receipt of submittals requiring review, the Engineer will review submittals and return them to the Contractor with results of the review indicated as follows:

1. NO EXCEPTION TAKEN: Means the submittals has been reviewed for conformance with the design concept of the Work and with the information given in the Contract Documents and no exceptions are taken; fabrication/installation may be undertaken. Approval does not authorize changes to the Contract Sum or Contract Time.

2. MAKE CORRECTIONS NOTED: Means submittal has been reviewed as above and certain exceptions are noted; Contractor may proceed with the work incorporating the notes, but shall revise and resubmit the submittal to the Engineer until no exceptions are taken.

3. REVISE AND RESUBMIT: Means submittal has been reviewed as above and is not acceptable for one of the reasons specified below. In resubmitting, limit corrections to items marked.

a. Not enough information is provided to make a determination.

b. Submittal contains too many errors or omissions to make a determination.

c. Information provided is not in conformance with the information given in the Contract Documents. Fabrication/installation may not be undertaken until submittal has been revised and resubmitted and approved by the Engineer.

4. REJECTED/SUBMIT SPECIFIED ITEM: Means submittal has been reviewed as above and been found to be not in compliance with information given in the Contract Documents and fabricated/installation may not be undertaken. Do not revise or resubmit submittals marked Rejected or Submit Specific Item.

END OF SECTION

SECTION 01 36 13 - CUTTING AND PATCHING

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Requirements and limitations for cutting and patching of work.

1.2 DESCRIPTION OF REQUIREMENTS

A. Definition: “Cutting and patching” includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting, and patching required to restore surfaces to their original condition. This includes removal and replacement of existing ACT ceilings.

1. Provide cutting and patching of existing work as required for the proper installation of new work, including proper interface with existing work.

2. Cutting and patching is performed for coordination of the work, installation of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed, to remove and replace work not conforming to Contract requirements, or for other similar purposes.

B. Refer to other sections of these specifications for specific cutting and patching requirements, and limitations applicable to individual units or work.

1. Unless otherwise specified, requirements of this Section apply to mechanical, electrical and plumbing work. Refer to Division 22 & 26 sections for additional requirements and limitations on cutting and patching of mechanical and electrical work.

1.3

A. Individual Specifications Sections:

1. Cutting and patching incidental to work of this Section.

2. Advance notification to other trades of openings required in work of those trades.

3. Limitations on cutting structural members.

1.4 QUALITY ASSURANCE

A. Requirements for Structural Work: Do not cut and patch structural work in a manner that would result in a reduction of load-carrying capacity or load-deflection ratio.

B. Before cutting and patching the following categories of work, submit a written request and obtain the Architect’s consent to proceed with cutting and patching, as described in the procedural proposal for cutting and patching.

1. Structural steel

2. Miscellaneous structural metals, including lintels, equipment supports, stair systems and similar categories of work

3. Structural concrete

4. Foundation construction

5. Shoring assemblies

6. Bearing and retaining walls

7. Structural decking

8. Exterior wall construction

9. Piping, ductwork, vessels and equipment

C. Operational and Safety Limitations: Do not cut and patch operational elements or safety related components in a manner that would result in a reduction of their capacity, to perform in the manner intended, including energy performances, or that would result in increased maintenance, or decreased operational life, or decreasing safety. Before cutting and patching the following elements of work, and similar work elements where directed, obtain the Architect's consent to proceed with cutting and patching.

1. Shoring, bracing, and sheeting

2. Primary operational systems and equipment

3. Water/moisture vapor/air/smoke barriers, membranes and flashings

4. Noise and vibration control elements and systems

5. Control, communication, conveying, and electrical wiring systems

6. Special construction, as specified by Division 13 sections

D. Visual Requirements: Do not cut and patch work exposed on the building's exterior or in its occupied spaces, in a manner that would, in the Architect's opinion, result in lessening the building's aesthetic qualities. Do not cut and patch work in a manner that would result in substantial visual evidence of cut and patch work. Remove and replace work judged by the Architect to be cut or patched in a visually unsatisfactory manner. If possible, retain the original installer or fabricator, or another recognized, experienced and specialized firm to cut and patch the following categories of exposed work:

1. Architectural concrete finishes

2. Brick and concrete unit masonry

3. Ornamental metal

4. Roofing

5. Preformed metal panels

6. Window system

7. Gypsum or cement plaster

8. Acoustical ceilings

9. Carpeting

10. Wall covering

11. HVAC enclosure, cabinets or covers

1.5 SUBMITTALS

A. Submit written request in advance of cutting or alteration which affects:

1. Structural integrity of any element of the project

2. Integrity of weather-exposed or moisture-resistant element

3. Efficiency, maintenance, or safety of any operational element

4. Visual qualities of sight-exposed elements

5. Work of Owner or separate contractor

6. Any work in or around any known or potential area in which asbestos or lead based products exist.

B. Procedural Proposal for Cutting and Patching: Where prior consent for cutting and patching is required, submit proposed procedures for this work well in advance of the time work will be performed, and request consent to proceed. Include the following information, as applicable, in the submittal:

1. Describe the nature of the work and how it is to be performed, indicating why cutting and patching cannot be avoided. Describe anticipated results of the work in terms of changes to and effects upon existing work, including structural, operational and visual changes, as well as other significant elements.

2. List products to be used and firms that will perform work.

3. Give dates when work is expected to be performed.

4. List utilities that will be disturbed or otherwise be affected by work, including those that will be relocated and those that will be temporarily out of service. Indicate how long utility services will be disrupted.

5. Where cutting and patching of structural work involves the additional reinforcement, submit details and engineering calculations to show how that reinforcement is integrated with the original structure to satisfy requirements.

6. Consent by the Architect to proceed with cutting and patching work does not waive the Architect's right to later require complete removal and replacement of work found to be cut and patched in an unsatisfactory manner.

1.6 PAYMENT FOR COSTS

A. Cost for work necessary to accommodate installation of new work shall be borne by the Contractor or subcontractor responsible for installing new work.

B. Costs caused by ill-timed or defective work, or work not conforming to contract documents, including costs for additional services of the Architect and other Design Consultants shall be borne by the party responsible in the judgment of Architect, for ill-timed, rejected or non-conforming work.

C. Costs for work performed on instruction of Owner, other than the correction of defective or non-conforming work shall be responsibility of the Owner, who shall issue an appropriate Change Order for the increase in costs.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Except as otherwise indicated, or as directed by the Architect, use materials for cutting and patching that are identical to existing materials. If identical materials are not available or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible, with regard to visual effect. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

PART 3 - EXECUTION

3.1 GENERAL

A. Execute cutting, fitting, and patching to complete work, and to:

1. Fit several parts together which will integrate with other work.

2. Uncover work to install ill-timed work.

3. Remove and replace defective and non-conforming work.

4. Remove samples of installed work for testing.

5. Provide openings in elements of work for penetrations of mechanical and electrical work.

6. Fill and refinish existing holes and damaged areas.

3.2 INSPECTION

A. Before cutting, examine the surface to be cut and patched and the conditions under which the work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding with the work.

3.3 PREPARATION

A. To prevent failure, provide temporary support of work to be cut.

B. Protect other work during cutting and patching to prevent damage. Provide protection from adverse weather conditions for that part of the project that may be exposed during cutting and patching operations.

C. Take precautions not to cut existing pipe, conduit or duct serving the building, but scheduled to be relocated until provisions have been made to bypass them.

3.4 PERFORMANCE

A. Employ skilled workmen to perform cutting and patching work. Except as otherwise indicated or as approved by the Engineer, proceed with cutting and patching at the earliest feasible time and complete work without delay.

B. Cut the work using methods that are least likely to damage work to be retained or adjoining work. Where possible, review the proposed procedures with the original installer; comply with original installer's recommendations.

1. In general, where cutting is required, use hand or small power tools designed for sawing or grinding, not hammering and chipping. Cut through concrete and masonry using a cutting machine such as a carborundum saw or core drill to ensure a neat hole. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces. Temporarily cover the opening when not in use.

2. Comply with requirements of applicable sections of Division 2 when cutting and patching, excavating and backfilling.

3. Bypass utility services such as pipe and conduit, before cutting, where such utility services are shown or required to be removed, relocated or abandoned. Cut-off conduit and pipe in walls or partitions to be removed. After bypassing and cutting, cap, valve or plug, and seal tight the remaining portion of pipe and conduit to prevent entrance of moisture or other foreign matter.

C. Patching: Patch with seams which are durable and as visible as possible. Comply with specified tolerances for the work.

1. Where feasible, inspect and test patched areas to demonstrate integrity of work.

2. Restore exposed finishes of patched areas, and where necessary, extend finish restoration into retained adjoining work in a manner which will eliminate evidence of patching and refinishing.

3. Where removal of walls or partitions extend one finished area into another finished area, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. If necessary to achieve uniform color and appearance, remove the existing floor and wall coverings and replace with new materials.

a. Where a patch occurs in a smooth painted surface, extend final paint coat over the entire unbroken surface containing the patch, after the patched area has received prime and base coat.

4. Patch, repair or rehang existing ceilings as necessary to provide an even plane surface of uniform appearance.

D. Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

E. At penetrations of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated material, full thickness of the construction element.

F. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

3.5 CLEANING

A. Thoroughly clean areas and spaces where work is performed or used as access to work. Completely remove paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finish is applied. Restore damaged pipe covering to its original condition.

END OF SECTION

SECTION 01 36 16 - REMODELING AND ALTERATION PROCEDURES

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. This Section contains general provisions and requirements pertaining to all remodeling, removal and relocation work in the existing building, and becomes a part of each Section and Division performing remodeling, removal and relocation work for this project, with the same force and effect as if written in full therein.

B. Take all necessary precautions to keep trespassers out of the work areas. Secure work areas from entry when work is not in progress.

C. Perform all remodeling, demolition, removal and relocation work in strict accordance with Owner's instructions and applicable Federal, State and local health and safety standards, codes and ordinances. Where conflicts occur, the more restrictive requirement shall govern.

1.2 EXISTING CONDITIONS

A. Obvious existing conditions, installations and obstructions affecting the work shall be taken into consideration as necessary. Work to be done is the same as though they were completely shown or described.

B. Items of existing construction indicated to remain upon completion of the Contract, but which require removal to complete the work, shall be carefully removed and replaced as required. The replaced work shall match its condition at the start of the work, unless otherwise required.

C. Visit the site and inspect all existing conditions, including access to the site, the nature of structures, objects and materials to be encountered, and all other facts concerning or affecting the work. Information on the drawings showing existing conditions does not constitute a guarantee that other items may not be found or encountered.

D. Utilities: Do not interrupt existing utilities serving occupied or used facilities, except when authorized by the Engineer in writing two weeks in advance. Provide temporary services during interruptions to existing utilities.

E. Stop work and notify Engineer and owner immediately if any hazardous materials are encountered (especially asbestos or lead based products).

PART 2 - PRODUCTS

2.1 SALVAGED MATERIALS

A. The Owner reserves the right of first refusal on all salvaged items. Remove remaining items from the site as work progresses. Storage or sale of items on site is not permitted. Burning of removed materials on site is not permitted.

B. Store salvaged items in a dry, secure place on site.

C. Salvaged items not required for use in repair of existing work shall remain the property of the Owner.

D. Do not incorporate salvaged or used material in new construction, except with permission of the Engineer.

2.2 PRODUCTS FOR PATCHING, EXTENDING AND MATCHING

A. Contract documents do not define products or standards of workmanship present in existing construction. Determine products by inspection and by use of the existing construction. Provide same or similar quality products or types of construction such as the existing structure, where needed to patch or extend existing work.

B. If reasonably matched products are not obtainable, improve appearance by minor relocating some of the existing products, and grouping new ones in a pattern arranged by the Engineer. Do not replace products scheduled for retaining because matching ones are not obtainable, except as directed by a Change Order.

PART 3 - EXECUTION

3.1 PROTECTION OF WORK TO REMAIN

A. Protect existing work from damage by use of barricades, tarpaulins, temporary walls, plywood, planking, masking, or other suitable means and methods as approved by the Engineer.

B. If work to remain in place is damaged, restore to original condition at no additional cost to the Owner.

C. Concealed Conditions: If conditions cause changes in the work from requirements of the Contract Documents, the Contract Sum will be adjusted in accordance with the General Conditions.

3.2 PROCEDURES

A. Refinishing at Removed Work: Cut below the surface of substrate materials and patch over the area of removal with finish materials so removal is not apparent.

B. Remove and replace existing ceilings, cut, patch, or replace existing walls, partitions and floors, as may be necessary for access to valves, piping, conduit and tubing by mechanical and electrical trades, as directed and approved by the Engineer. Work involved shall be performed by the appropriate subcontractor, or by other properly qualified subcontractors.

C. Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship. Quality of patched or extended work shall not be less than that specified for new work.

D. Cutting:

1. Concrete and Masonry: Saw cut where feasible.

2. Plaster: Cut back to sound plaster on straight lines, and back-bevel edges of remaining plaster. Trim and prepare existing lath for tie-in of new lath.

3. Woodwork: Cut back to a joint or panel line. Undamaged removed materials may be reused.

4. Resilient Tiles: Remove in whole units to natural breaking points or straight joint lines, with no damaged or defective existing tiles remaining where joining new construction.

5. Salvaged Materials: Carefully remove to avoid damage, thoroughly clean and reinstall as indicated, or store as directed.

6. Doors: Remove in such manner as to facilitate filling in of openings or installation of new work, as required by the drawings.

7. Structural Elements: Remove only as shown on the Structural drawings. If not specifically shown, but removal is required, perform such removal or alteration only upon written approval of the Engineer. Do not damage or alter any structural element of the existing building.

E. Patching:

1. Match existing work where possible; if unavailable, use salvage material for patching, and provide totally new material in areas where salvage has been removed. Consult with the Engineer concerning locations for salvaging materials.

2. Repairs or continuations of existing work shall be relatively imperceptible in the finished work when viewed under finished lighting conditions from a distance of 6 feet.

3. Patching, Repairing, and Finishing of Existing Work: Perform in compliance with the applicable requirements of the specification section covering the work to be performed and the requirement of this Section.

F. Erect scaffolding as necessary to gain access to the various parts of the work. Provide structurally sound, rigidly braced and properly constructed scaffolding, shoring and bracing as necessary to positively protect the affected elements and building, and to support the activities or workmen and loads. Design and construction of scaffolds and supports shall be in accordance with applicable safety regulations. Material used shall be adequate to support anticipated loads with a properly calculated margin of safety.

G. Noise Producing Equipment: Minimize use of noise producing equipment. Limit excessive noise to periods of vacancy or provide sound control. Arrange schedules in advance with the Engineer.

3.3 EXISTING FURNITURE AND EQUIPMENT

A. Owner Salvaged Items: Personal items in areas subject to remodeling will be removed before construction in those areas commences.

B. Furniture Items: Owner will remove furniture and equipment from small rooms or relocate furniture and equipment to the edges or corners of larger rooms before remodeling commences. Contractor shall exercise care to prevent damage to remaining furniture and equipment. Contractor is responsible for cleaning furniture or equipment that is soiled with construction related materials or debris.

3.4 PAINTING AND FINISHING

A. Preparation: Prepare patched areas as required for new work. Wash existing painted surfaces with neutral soap or detergent, thoroughly rinse, and sand when dry.

B. Painting and Finishing: Conform to the applicable provisions of the Painting Section. Prepare bare areas and patches in existing painted surfaces with specified primer and intermediate coats, sanded smooth and flush with adjoining surfaces.

3.5 DISPOSAL OF DEBRIS

A. Remove material, debris and rubbish resulting from work of this Section from the building and site as it accumulates. Keep all areas of work in “broom clean” condition as the work progresses.

B. At completion of renovation and remodeling work in each area, provide final cleaning and return space to a condition suitable for use by the Owner.

END OF SECTION

SECTION 01 41 00 - REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 DEFINITIONS

A. GENERAL: Basic Contract definitions are included in the General Conditions.

B. Indicated refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in Specifications, and similar requirements in Contract Documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used, it is to help locate the reference; no limitation on location is intended except as specifically noted.

C. DIRECTED: Terms such as "directed", "requested", "authorized", "selected", "approved", "required", and "permitted" mean "directed by the Engineer", requested by the Engineer", and similar phrases. However, no implied meaning shall be interpreted to extend the Engineer's responsibility into the Contractor's area of construction supervision.

D. APPROVE: The term "approved", where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the duties and responsibilities of the Engineer as stated in General and Supplementary Conditions. Such approval shall not release the Contractor from responsibility to fulfill Contract requirements unless otherwise provided in the Contract Documents.

E. REGULATION: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work, whether lawfully imposed by authorities having jurisdiction or not.

F. FURNISH: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations".

G. INSTALL: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations".

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

I. INSTALLER: An "Installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or sub-subcontractor for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

J. Project Site is the space available to the Contractor for performance of construction activities, either exclusively or in conjunction with others performing other construction activities as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land upon which the Project is to be built.

K. TESTING LABORATORIES: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.2 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. SPECIFICATION FORMAT: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 23-Division format and MASTERFORMAT numbering system.

B. SPECIFICATION CONTENT: This Specification uses certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. ABBREVIATED LANGUAGE: Language used in the Specifications and other Contract Documents is the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and where the full context of the Contract Documents so indicates.

2. Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.

C. ASSIGNMENT OF SPECIALISTS: The Specification requires that certain specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.

1. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

2. TRADES: Use of titles such as "carpentry" is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter". It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.

1.3 INDUSTRY STANDARDS

A. APPLICABILITY OF STANDARDS: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections indicate which codes and standards the Contractor must keep available at the Project Site for reference.

B. PUBLICATION DATES: Where the date of issue of a referenced standard is not specified, comply with the standard in effect as of date of Contract Documents.

1. UPDATE STANDARDS: At the request of the Engineer, Contractor, or authority having jurisdiction, submit a Change Order proposal where an applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected. The Engineer will decide whether to issue a Change Order to proceed with the updated standard.

C. CONFLICTING REQUIREMENTS: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Engineer for a decision before proceeding.

1. MINIMUM QUANTITY OR QUALITY LEVELS: In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to the Engineer for a decision before proceeding.

D. COPIES OF STANDARDS: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.

E. ABBREVIATIONS AND NAMES: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change and are believed to be, but are not assured to be, accurate and up to date as of the date of Contract Documents.

AA Aluminum Association
900 19th St., NW, Suite 300
Washington, DC 20006
(200) 862-5100

AAMA American Architectural Manufacturer's Association
2700 RIVER RD.,Suite 118
Dds Plaines, IL 60018
(312) 699-7310

ALI Associated Laboratories
641 S. Vermont St.
Palatine, IL 60067
(312) 358-7400

ALSC American Lumber Standards Committee
P.O. Box 210
Germantown, MD 20874
(301) 972-1700

ACI	American Concrete Institute P.O. BOX 19150 Detroit, MI 48219 (313) 532-2600
ACIL	American Council of Independent Laboratories 1725 K St., NW Washington, DC 20006 (202) 887-5872
AGA	American Gas Association 1515 Wilson Blvd.Arlington, VA 22209 (703) 841-8400
AI	asphalt Institute Asphalt Institute Building College Park, MD 20740 (310) 277-4258
AIA	American INSTITUTE OF ARCHITECTS 1735 New York AVE, NW WASHINGTON, DC 20006 (202) 626-7300
A.I.A.	AMERICAN INSURANCE ASSOCIATION 85 JOHN ST.NEW YORK, NY 10038 (212) 669-0400
AIHA	American Industrial Hygiene Association 475 Wolf Ledges Parkway Akron, OH 44311 (216) 762-7294
AISC	American Institute of Steel Construction 400 N. Michigan Ave., 8th Floor Chicago, IL 60611 (312) 670-2400
AITC	American Institute of Timber Construction 333 W. Hampden Ave. Englewood, CO 80110 (303) 761-3212
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018 (212) 354-3300
APA	American Plywood Association P.O. Box 11700 Tacoma, WA 98411 (206) 565-6600
API	American Petroleum Institute 1220 L St., NW Washington, DC 20005 (202) 682-8000
ARMA	Asphalt Roofing Manufacturers Association 6288 Montrose Rd. Rockville, MD 20852 (301) 231-9050
ASC	Adhesive and Sealant Council 1500 Wilson Blvd., Suite 515 Arlington, VA 22209 (703) 841-1112
ASME	American Society of Mechanical Engineers 345 East 47th St. New York, NY 10017 (212) 705-7722
ASTM	American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103 (215) 299-5400
AWS	American Welding Society P.O. Box 351040, 550 Le Jeune Road, NW Miami, FL 33135 (305) 443-9353
ISA	Instrument Society of America P.O. Box 12277; 67 Alexander Drive Research Triangle Park, NC 27709 (919) 549-8411

AWWA	American Water Works Association 6666 W. Quincy Ave. Denver, CO 80235 (303) 794-7711	LPI	Lightning Protection Institute P.O. Box 458Harvard, IL 60033 (815) 943-7211
BHMA	Builders' Hardware Manufacturers Association 60 E. 42nd. St., Room 511 New York, NY 10165 (212) 682-8142	ML/SFA	Metal Lath/Steel Framing Association 600 S. Federal St., Suite 400 Chicago, Il 60605 (312) 922-6222
CDA	Copper Development Association Box 1840, Greenwich Office Park 2 Greenwich, CT 06836 (203) 625-8210	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry 127 Park St., NE Vienna, VA 22180 (703) 281-6613
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Rd. Schaumburg, IL 60195 (312) 490-1700	NAAMM	National Association of Architectural Metal Mfg. 600 S. Federal St., Suite 400 Chicago, IL 60605 (312) 922-6222
EIA	Electronic Industries Association 2001 Eye St., NW Washington, DC 20006 (202) 457-4900	NCMA	National Concrete Masonry Association P.O. Box 781 Herndon, VA 22070 (703) 435-4900
ETL	ETL Testing Laboratories, Inc. P.O. Box 2040Route 11, Industrial Park Cortland, NY 13045 (607) 753-6711	NEC	National Electric Code (from NFPA)
FM	Factory Mutual Engineering and Research 1151 Boston-Providence Turnpike Norwood, MA 02062 (617) 762-4300	NECA	National Electrical Contractors Association 7315 Wisconsin Ave. Bethesda, MD 20814 (301) 657-3110

ICEA Insulated Cable Engineers Association Inc.
P.O. Box P
South Yarmouth, MA 02664
(617) 394-4424

IEC International Electrotechnical Commission
(Available from ANSI)
1430 Broadway
New York, NY 10018
(212) 354-3300

IEEE Institute of Electrical and Electronic Engineers
345 E. 47th St.
New York, NY 10017
(212) 705-7900

IRI Industrial Risk Insurers
85 Woodland St.
Hartford, CT 06102
(203) 520-7300

PCA Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077
(312) 966-6200

PDI Plumbing and Drainage Institute(c/o Saul Baker)
1106 W. 77th St., South Dr.
Indianapolis, IN 46260
(317) 251-6970

RMA Rubber Manufacturers Association
1400 K St., NW
Washington, DC 20005
(202) 682-4800

SDI Steel Deck Institute
P.O. Box 9506
Canton, OH 44711
(216) 493-7886

SJI Steel Joist Institute
1205 48th Street North;

NEMA National Electrical Manufacturers Association
2101 L St., NW, Suite 300
Washington, DC 20037
(202) 457-8400

NFPA National Fire Protection Association
Battlemarch Park
Quincy, MA 02269
(617) 770-3000

NPCA National Paint and Coating Association
1500 Rhode Island Ave., NW
Washington, DC 20005
(202) 462-6272

NSSEA National School Supply and Equipment Association
2020 Fourteenth St. North, Suite 400
Arlington, VA 22201
(703) 524-8819

SSPC Steel Structures Painting Council
4400 Fifth Ave.
Pittsburgh, PA 15213
(412) 268-3327

TIMA Thermal Insulation Manufacturers Association
8341 Sangre de Cristo RoadLittleton, CO 80217
(303) 933-9774

UL Underwriters Laboratories
333 Pfingsten Rd.
Northbrook, UL 60062
(312) 272-8800

WRI Wire Reinforcement Institute
8361-A Greensboro Drive
McLean, VA 22102
(703) 790-9790

WWPA Woven Wire Products Association
2515 N. Nordica Ave.

Suite A
Myrtle Beach, SC 29577
803) 449-0487

Chicago, IL 60635
(312) 637-1359

F. FEDERAL GOVERNMENT AGENCIES: Names and titles of federal government standard or Specification producing agencies are frequently abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard or Specification producing agencies of the federal government. Names and address are subject to change but are believed to be, but are not assured to be, accurate and up to date as of the date of the Contract Documents.

CE	Corps of Engineers (U.S. Department of the Army) Chief of Engineers - Referral Washington, DC 20314 (202) 272-0660	NIST	National Institute of Standards and Technnology (U.S. Department of Commerce) Gaithersburg, MD 20899 (301) 975-2000
CFR	Code of Federal Regulations Available from the Government Printing Office N. Capital St. between G and H St. WWashington, DC 20402(202) 783-3238 (Material is usually first published in the Federal Register	DOT	Department of Transportation 400 Seventh St., SW Washington, DC 20590 (202) 366-400
CPSC	Consumer Product Safety Commission 5401 Westbard Ave. Bethesda, MD 20816 (800) 638-2772	EPA	Environmental Protection Agency 401 M St., SW Washington, DC 20460 (202) 382 2090
CS	Commercial Standard(U.S. Department of Commerce) Government Printing Office Washington, DC 20402 (202) 377-2000	FAA	Federal Aviation Administration (U.S. Department of Transportation) 800 Independence Ave., SW Washington, DC 20590 (202) 366-4000
DOC	Department of Commerce14th St. and Constitution Ave., NW Washington, DC 20230 (202) 377-2000	FHA	Federal Housing Administration (U.S. Department of Housing and Urban Development) 451 Seventh St., SW

			Washington, DC 20201 (202) 755-6422
FS	Federal Specification (from GSA) Specifications Unit (WFSIS)7th and D St., SW Washington, DC 20406 (202) 472-2205 or 472-2140	OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) Government Printing Office Washington, DC 20402 (202) 523-6091
GSA	General Services Administration F St. and 18th St., NW Washington, DC 20405 (202) 472-1082	PS	Product Standard of NBS (U.S. Department of Commerce) Goernement printing Office Washington, DC 20402 (202)783-3238
MIL	Military Standardization Documents (U.S. Department of Defense) Naval Publications and Forms Center 5801 Tabor Ave. Philadelphia, pa 19120	USDA	U.S. Department of Agriculture Independence Ave. between12th and 14th St., SW Washington, DC 20250 (202) 447-8732

1.4 GOVERNING REGULATIONS/AUTHORITIES

A. The Engineer has contacted authorities having jurisdiction where necessary to obtain information necessary for the preparation of Contract Documents; that information may or may not be of significance to the Contractor. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work.

1. COPIES OF CORRESPONDENCE: During preparation of the Contract Documents, the Engineer maintained a file of correspondence with authorities having jurisdiction. This file is available at the Engineer's office for reference. If requested, the Engineer will provide copies of correspondence at cost of reproduction.

B. SUBMITTALS

1. PERMITS, LICENSES, AND CERTIFICATES: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01 45 23.13 - OBSERVATION PROCEDURES

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope of Work:

1. The Contractor shall coordinate and cooperate with Engineer and Engineer's Consultants as required for on-site observations and monitoring of the Work.

B. Related Work:

1. Section 01 45 23 – Testing and Inspection Services

1.2 RELATED REQUIREMENTS

A. Coordination, scheduling and implementation of inspections and testing required by laws, ordinances, rules, regulations, orders or approvals, or public authorities required for interim and final approval of the Work shall be the sole responsibility of the Contractor.

B. Contractor shall maintain a log of all required governmental interim and final inspections throughout the progress of the Work.

PART 2 – PRODUCTS

2.1 GENERAL

A. Throughout the progress of the Work, the Owner's A/E consultants shall make regular site visits and prepare observation reports.

B. Contractor and requested subcontractors shall be present for all A/E observations. Coordinate with A/E field representatives as required.

C. Contractor shall coordinate all trades as required to address issue or deficiencies identified on the observation reports.

2.2 OBSERVATION REPORTS

A. Upon completion of on-site observations by the Engineer and Engineer's Consultants, documentation of the Observation shall be furnished to the Contractor.

B. Observation report items that reflect instructions for corrective measures shall be addressed / corrected by the Contractor in a timely manner.

C. Upon completion of corrective measures, Contractor shall detail corrective measures, including date(s) of work and date(s) of Contractor's verification of completeness on the observation report(s) and return a copy the Engineer and Consultant as appropriate.

D. Wherever possible, Contractor's written documentation shall include all corrective work identified to be addressed on the observation report. Minimize piece meal responses as much as possible.

E. A complete history of Contractor's observation responses shall be required to be submitted as a condition of project close-out.

PART 3 – GENERAL – PROJECT CONSULTANT OBSERVATIONS

3.1 DESCRIPTION

A. The Contractor shall allow in his Proposal the coordination and scheduling of Observations to be performed by the Owner's project consultants; including the Engineer, Architect, Structural Engineer, as they may apply to this Work.

B. All project consultant observation services shall be performed by designees of the relative consultant; upon which the Contractor may rely as to the capability and thoroughness of the observation being performed. Upon request by the Contractor, the names of A/E field representatives performing specific observations shall be furnished by the Engineer.

C. The Owner shall pay for the observation services of the project consultants in accordance with the Owner – Engineer Agreement and the requirements of the Contract Documents. Excessive observations and re-observations resulting from the Contractor's actions as described in this section, shall be paid for by the Contractor directly to the affected Consultant.

D. The Contractor shall cooperate with the Owner's project consultants in all matters pertaining to required observations of the work as described in the Contract Documents. The Owner retains the option to add to or delete any or all observations specified herein; and thereby accept the relative work without observation.

E. Refer to Section 01 31 29 – Notification of Engineer Requirements for additional information.

3.2 RELATED REQUIREMENTS

A. Respective Sections of Specifications describing the required consultant observations.

3.3 AUTHORITIES AND DUTIES OF THE A/E FIELD REPRESENTATIVES

A. The project consultant representatives are not authorized to revoke, alter, relax, increase, or release the Contractor from any requirement of the Contract Documents without written notice furnished to the Contractor by the Engineer.

B. When it appears that the material, assembly or work performed by the Contractor fails to fulfill Contract requirements, the project consultant representative shall promptly notify the General Contractor, Engineer and Owner.

C. The project consultant representative(s) shall promptly distribute copies of the observation reports. Standard distribution shall include copies of all reports to the Owner, Engineer, and General Contractor.

3.4 PROJECT CONSULTANT OBSERVATION GUIDELINES AND PROCEDURES

A. Project Consultants shall make all observations required in the Contract Documents and requested by the Contractor and Owner.

B. For each material, assembly or phase observation required in the Contract Documents, and upon request by the Contractor, the project consultant(s) shall perform the following observations as required in the Owner – Engineer Agreement; and shall be at the expense of the Owner in accordance with the Owner – Engineer Agreement.:

1. Initial observation to determine compliance with the Contract Documents.

2. Observation to determine deficiencies where the initial observation results do not show 100% compliance with the Contract Documents. At the consultant's discretion, this observation may be performed concurrent with the initial observation.

3. Re-observation to determine 100% compliance with the Contract Documents.

C. The Contractor shall bear the responsibility of requesting and scheduling all project consultant observations required by the Contract Documents. The Contractor shall give the project consultant a minimum of forty-eight (48) hours' notice prior to the requested observation.

1. No extension of Contract Time shall be granted for untimely observations due to the Contractor's failure of proper observation request notification.

END OF SECTION

SECTION 01 45 23 - TESTING AND INSPECTION SERVICES

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Refer to Section AB - Instructions to Proposers and Section AF – Manufacturer Prequalification for substitutions.

B. Scope of Work:

1. The Contractor shall allow in his proposal the coordination and supervision of tests to be performed by an independent laboratory selected by the Owner.

2. Testing laboratory services specified in the Contract Documents shall be provided and paid for by the Owner outside of this Contract.

3. A testing lab shall be selected by the Owner, and the Contractor shall be notified as soon as possible.

4. The Contractor shall cooperate with the testing laboratory in all matters pertaining to the work. The Owner retains the option to add to or delete any or all testing specified herein.

5. Inspections and testing required by laws, ordinances, rules, regulations, orders or similar requirements of authorities having jurisdiction shall be included in the Contractor’s proposal and paid for by the Contractor.

C. Related Work:

1. Each Specification Section Listed: Laboratory test required and standards for testing.

2. Testing laboratory inspection, sampling and testing is required for:

a. Electrical, plumbing and mechanical tests required in relative specification sections.

b. As requested by the Owner or Engineer

1.2 AUTHORITIES AND DUTIES OF THE TESTING LABORATORY

A. The testing laboratory shall provide testing services under a separate agreement with the Owner or Engineer, who shall be responsible for the costs of initial testing – pass or fail.

1. The Contractor shall be responsible for costs of all re-tests required to achieve passing results.

2. The Contractor shall be responsible for charges of the testing lab for expenses incurred for cancelled and / or mis-scheduled testing requests.

3. The testing lab shall invoice Contractor direct for all re-tests of failed initial tests; and send copies of the invoices to the Engineer and Owner for record.

4. The testing lab and Contractor shall be responsible to negotiate and execute a separate agreement if required by the testing lab for charges described above.

B. The laboratory is not authorized to revoke, alter, relax, enlarge, or release any requirement of the Specifications, or to approve or accept any portion of the work.

1. When it appears that the material furnished, or work performed by the Contractor fails to fulfill specification requirements, the testing laboratory shall promptly notify the Contractor, Engineer and Owner of work being tested of such deficiencies.

C. The laboratory shall promptly distribute copies of the laboratory test and inspection reports. Standard distribution shall include copies of all reports to the Owner, Engineer, and Contractor.

1. Electronic distribution of test reports / results is mandatory.

D. The testing lab is required to furnish a report of the status of testing performed as it relates to anticipated expenses described in the Agreement with the testing lab. Reports shall be furnished at most bi-monthly to the Owner and Engineer.

1. Report information shall include verification that Owner paid testing progress corresponds with anticipated expenses.

2. The testing lab shall be required to notify the Engineer and Owner immediately if / when the testing lab anticipates exceeding the lump sum fee agreed to by the Owner.

3. Such notification must occur prior to expensing 75% of the testing lab fee.

1.3 TESTING LABORATORY CONTRACTUAL RELATIONSHIPS

A. The Owner shall contract with the Testing Laboratory outside the Owner-Contractor Agreement.

B. The Owner shall pay for the initial laboratory services / tests – pass or fail.

C. In the case of a failed test that does not meet the specified requirements, the Contractor shall be responsible for payment directly to the Testing Laboratory for all services / re-testing required to achieve a passing result.

1. The Owner shall not be invoiced for services or re-testing associated with failed initial tests.

D. The Testing Laboratory is responsible for making separate arrangements with the Contractor for reimbursement of services or re-testing associated with failed initial tests.

1.4 TESTING LABORATORY GUIDELINES AND PROCEDURES

A. Technicians scheduled to perform specific testing services must be qualified to review and perform other services that overlap (i.e., earthwork, foundation inspections, rebar inspection, and concrete), when scheduled concurrently at the project site.

B. Technician time for services performed will be reimbursed at a regular time rate. Compensation at the overtime rate will be considered for any hours over eight hours spent at the job site on a single day, field testing services performed on a Saturday or Sunday, and any field services performed on a recognized holiday.

C. Concrete design mixes will receive a cursory review with any discrepancies reported to the Engineer.

D. Nuclear density testing will be based on a daily rental rate for the actual testing equipment; compensation on a per test basis will not be considered.

E. Report distribution shall include the Owner, Engineer, Contractor, Civil Engineer, Structural Engineer, and others requesting or requiring review of the specific testing results.

F. Job site trips solely for cylinder pick-up shall be minimized. Whenever possible, cylinder / specimen pick-up shall be conducted when a technician is scheduled to be on-site for other testing work.

G. Structural steel inspections shall include a plant visit reviewing shop fabrication, welding and an overall review of the shop fabrication quality control standards.

1. Structural steel field inspection shall include a 100% visual review of all field fillet welds and initial frequency of 25% ultrasonic testing of full field penetration welds.

2. There shall be 100% visual review of all bolted connections, and a minimum of two (2) bolts tested at every bolted connection.

H. The Contractor shall bear the responsibility of scheduling all testing services. The Contractor and the testing laboratory shall assume full responsibility to coordinate the testing services. Cancellations and/or failed tests will be reimbursable to the Owner by the responsible party for the cancellation or failure of a test or service.

PART 2 – GOVERNMENTAL INSPECTIONS AND CONTRACTOR TESTING

2.1 GOVERNMENTAL INSPECTIONS

A. The Contractor shall allow in his Proposal the application, coordination, scheduling and cost of all on-site inspections to be performed by governmental authorities having jurisdiction which are required for approval of the Work and occupancy of the building; including, but limited to:

1. City departments

2. County departments

3. Municipal Utility Districts

4. Health Departments

5. Fire Marshall Offices.

B. The Contractor shall make all corrective measures in accordance with instructions received from the governing authority inspector having jurisdiction, as required to receive 100% approval for the work being inspected.

C. The Contractor shall record and keep record of all governmental agency tests and inspections; including deficiencies noted by the agency, and corrective action(s) taken to receive final approval of the agency.

D. The Contractor shall bear all costs for initial inspections, re-inspections and any other expenses related to on-site inspections made by governing authorities.

E. No allowance shall be made for additional Contract Time, nor an increase in the Contract Sum for any unanticipated expenses or delays resulting from failed governmental inspection or resulting re-inspections required to obtain agency approval(s).

2.2 BELOW SLAB SANITARY SEWER TESTING

A. In addition to normal industry / governmental testing required for the sanitary sewer system, Contractor shall allow in his Proposal the application, coordination, scheduling and cost to provide a static water test(s) as described below.

B. The contractor shall perform a static pressure test on all sanitary sewer piping systems below the building slab.

C. The test(s) shall be maintained continuously from the time the pipe installation is initially tested prior to final cover-up and continue throughout all foundation preparation and placement of concrete slabs; and terminating a minimum of seven (7) days after the placement of concrete slabs.

D. Maintain sealed caps on all stub-ups to prevent dissipation of water within the piping system.

E. Any failure of the static testing indicating leakage during the above period shall be immediately reported to the Engineer, MEP Engineer and Owner.

F. The Contractor shall be responsible for all corrective measures necessary to repair and / or replace defecting piping as directed by the Engineer.

PART 3 – OWNER CONSULTANT OBSERVATIONS AND INSPECTIONS

3.1 GENERAL

A. Throughout the progress of the Work, the Owner’s A/E consultants shall make regular site visits and prepare observation reports.

B. Contractor and requested subcontractors shall be present for all A/E observations. Coordinate with A/E field representatives as required.

C. Contractor shall coordinate all trades as required to address issue or deficiencies identified on the observation reports.

D. Upon completion of corrective measures, Contractor shall note corrective measures, including date(s) on the observation report(s) and distribute the Engineer.

3.2 TEXAS DEPARTMENT OF LICENSING AND REGULATION (TDLR)

A. If required, the Owner /Engineer shall be responsible for interfacing with Texas Department of Licensing and Registration (TDLR) regarding state approval for compliance with Texas Accessibility Standards.

B. The Owner /Engineer shall make the initial submission of the Contract Documents for review.

C. TAS review comments affecting the Work shall be incorporated into the Work as directed by the Engineer either by Addendum, Change Proposal Request, Minor Change or Clarification.

D. During the progress of the Work, the Contractor shall bring to the Engineer’s attention any portion of the Work that may be questionably compliant with TDLR / TAS.

E. The Engineer shall coordinate and manage the TAS inspection of the completed project.

1. TAS required corrective measures due to design issues shall be paid for by the Owner.

2. TAS required corrective issues due to Contractor issues (materials, installation, etc.) shall be paid for by the Contractor.

F. All corrective work shall be completed within thirty (30) days after notification unless otherwise agreed upon by the Owner.

END OF SECTION

SECTION 01 52 00 - CONSTRUCTION FACILITIES

PART 1 GENERAL

1.1 DESCRIPTION

A. Specific administrative and procedural minimum actions are specified in this Section, as extensions of provisions in other Contract Documents. These requirements have been included for special purposes as indicated. Nothing in this Section is intended to limit types and amounts of temporary work required, and no omission from this Section will be recognized as an indication that such temporary activity is not required for successful completion of the Work and compliance with requirements of the Contract Documents. Provisions of this Section are applicable to, but are not limited to the temporary power, temporary water, first aid facilities, fire protection, construction aids, and parking facilities as further expanded in this section.

1.2 JOB CONDITIONS

A. General: Establish and initiate use of each temporary facility at time first reasonable required for proper performance of the Work. Terminate use and remove facilities at earliest reasonable time, when no longer required or when permanent facilities have, with authorized use, replaced their need.

B. Conditions of use:

1. Install, operate, maintain and protect temporary facilities in a manner and at locations which will be safe, non-hazardous, sanitary, and protective of persons and property, and free of delirious effects.

2. Contractor shall be responsible for overloading or excess use of or damage resulting from the overloading or excess use of existing utilities.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Materials, not specifically described herein, but required for proper completion of Work of this Section, may be new or used as selected by the Contractor, but shall be of design, type, size, and strength recommended intended purpose.

B. Items required to protect the tenants, workmen, and public from danger, shall be sufficiently designed to protect them. Where required. Excluded the public from all hazards.

PART 3 – EXECUTION

3.1 UTILITIES

A. Temporary Power: Project site has existing electrical services which may be utilized during performance of the Work, subject to approval of the Owner. Contractor may use existing facilities' power outlets, but shall provide all necessary temporary wiring, lamps, and equipment to complement the existing power service in capacity and with characteristics as required to complete Work.

B. Temporary Water: Project site has existing water which may be utilized during performance of the Work, subject to approval of the Owner. Contractor may use existing facilities' water, but shall provide all necessary temporary hoses and equipment required to complete Work.

3.2 SANITARY FACILITIES

A. The Contractor may use the Owner's sanitary facilities but must keep clean at all times.

3.3 STORAGE FACILITIES

A. Provide and maintain adequate weather tight lockable storage facilities, raised above the ground, with sides and top enclosed.

B. Replace materials improperly stored and damaged by weathered conditions.

C. Remove storage facilities when materials are stored within the structure in a weather tight condition.

D. Allow for temporary freeze protection as needed.

3.4 SIGNS

A. Signs permitted at the site:

1. Warning signs

2. Direction signs

3. Identification signs at field office

4. Emergency medical service sign.

B. Contractor shall allow no other signs to be displayed at the project site, unless authorized by the Owner.

3.5 BARRIERS

A. Provide temporary barricades on all portions of the site adjacent to the construction and accessible to the public.

3.6 SECURITY

A. Determine if and when watchmen, fencing or both are necessary for protection of the Work, and provide such services when necessary. Neither provision of watchmen or fencing nor the failure to provide them shall relieve the Contractor of responsibility in event of injury to person or damage to property.

3.7 CLEANING

A. Trash Removal: Clear the building and site of trash resulting from Work at least once a week. When rapid accumulation occurs, make more frequent removals. Remove highly combustible trash such as paper cardboard daily. Dumpsters shall not be allowed to overflow and should be emptied on a regular basis.

B. Disposition of Debris: Remove debris from site and make legal disposition. Locations for disposal shall be of the Contractor's choice within the above restriction. No debris or material may be buried or burned at the site. Take necessary precautions to prevent accidental burning of materials by avoiding large accumulations of combustible materials.

C. Final Cleaning: Thoroughly clean the work, including the removal of smudges, marks, stains, fingerprints, soil, Dirt, paint spots, dust, lint, discolorations, and other foreign materials.

3.8 TEMPORARY FIRST AID FACILITIES

A. Provide first aid equipment and supplies, with qualified personnel continuously available to render first aid at the site.

B. Provide a sign, posted in a conspicuous location, listing the telephone numbers for emergency medical services: Physicians, ambulance services and hospitals.

3.9 TEMPORARY FIRE PROTECTION

A. Provide a fire protection and prevention program for employees and personnel at the site; and provide and maintain fire extinguishing equipment ready for instant use at all areas of the Project and at specific areas of critical fire hazard.

B. Equipment:

1. Hand extinguishers of the types and sizes recommended by National Board of Fire Underwriters to control fires from particular hazards.

2. Barrels of water with buckets designated for fire-control purposes.

3. Water hoses connected to an adequate water pressure and supply system.

C. Enforce fire-safety discipline:

1. Store volatile materials in a n isolated, protected location.

2. Avoid accumulations of flammable debris and waste in or about the Project.

3. Prohibit smoking in the vicinity of hazardous conditions.

4. Closely supervise welding and torch-cutting operations in the vicinity of combustible materials and volatile conditions.

5. Supervise locations and operations of portable heating units and fuel.

D. Maintain fire extinguishing equipment in working condition, with current inspection certificate attached to each extinguisher.

3.10 CONSTRUCTION AIDS

A. Provide construction aids and equipment required to assure safety for personnel and to facilitate the execution of the work; scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes and other equipment.

B. Maintain all equipment in a first-class, safe condition.

3.11 PARKING FACILITIES

A. Coordinate location of parking for personnel and employees at each facility with school district, located to avoid interference with traffic, work or storage areas, or with materials-handling equipment.

END OF SECTION

SECTION 01 74 00 - CONSTRUCTION CLEANING

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Administrative and procedural requirements for final cleaning at Substantial Completion.

1.2 RELATED DOCUMENTS

A. Drawings, Specifications and provisions of Construction Contract, including General, Special and Supplementary Conditions and other General Requirements.

1.3 RELATED SECTIONS

A. Other Division 1 Specifications including, but not limited to:

1. Section 01 31 00 – Floor and Wall Protection

2. Section 01 50 00 – Temporary Facilities

3. Section 01 77 00 – Closeout Procedures

4. Special cleaning requirements for specific construction elements are included in appropriate Sections of Divisions 2 through 16

1.4 QUALITY ASSURANCE

A. Multiple Prime Contracts: Each prime contractor is responsible for final cleaning its own work. Project Manager is responsible for coordinating final cleaning of an area or piece of equipment where more than one prime contractor is involved.

1.5 SITE CONDITIONS

A. Environmental Requirements: Conduct cleaning and waste disposal operations in compliance with applicable laws, including, without limitation, Environmental Laws.

a. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.

b. Burning or burying of debris, rubbish, or other waste material on premises is not permitted.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Employ experienced workers or a professional cleaning service for final cleaning. Clean each surface or unit of Work to condition expected from commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

B. Complete following cleaning operations applicable to project before requesting inspection for certification of Substantial Completion for entire Project or portion of Project.

1. Clean site, yard and grounds in areas disturbed by construction activities including landscape development areas, of rubbish, waste material, litter, and foreign substances.

    a. Sweep paved areas broom clean. Utilize magnetic sweeps on parking lots to remove all metallic debris capable of causing vehicle tire damage.

2. Remove petrochemical spills, stains, and other foreign deposits.

3. Remove tools, construction equipment, machinery, and surplus material from Site.

    a. Clean exposed exterior and interior hard-surfaced finishes including doors, hardware and casework, to dirt-free condition, free of stains, films and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to original condition.

4. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

5. Broom clean concrete floors in unoccupied spaces.

6. All carpeting in work areas shall be cleaned by a professional carpet cleaning company acceptable to the owner. Carpet shall be thoroughly vacuumed prior to the use of hot water extraction.

7. 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 glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

8. Remove labels that are not permanent labels.

9. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

    a. Do not paint over "UL" and similar labels, including mechanical and electrical name plates.

10. Wipe surfaces of mechanical and electrical equipment, elevator equipment and similar equipment. Remove excess lubrication, paint and mortar droppings and other foreign substances.

11. Clean plumbing fixtures to sanitary condition, free of stains, including stains resulting from water exposure.

12. Replace disposable air filters and clean permanent air filters; clean exposed surfaces of diffusers, registers, and grilles.

13. Clean ducts, blowers and coils if units were operated without filters during construction.

14. Clean any construction related soiled food-service equipment to sanitary condition, ready and acceptable for intended use.

15. Clean light fixtures, lamps, globes and reflectors to function with full efficiency. Wipe handprints and paint clean in the ceiling grids following testing and balancing of HVAC system.

16. Thoroughly clean the work, including the removal of smudges, marks, stains, fingerprints, soil, dirty, paint spots, dust, lint, discolorations and other foreign materials.

17. Disposition of Debris: Remove debris from site and make legal disposition. Locations for disposal shall be of the Contractor's choice within the above restriction. No debris or material may be buried or burned at the site. Take necessary precautions to prevent accidental burning of materials by avoiding large accumulations of combustible materials.

18. Trash Removal: Clear the building and site of trash at least once a week. When rapid accumulation occurs, make more frequent removals. Remove highly combustible trash such as paper, cardboard, daily.

19. Leave Site and Work clean and ready for occupancy.

C. Remove temporary protection and facilities installed during construction to protect previously completed installations during remainder of construction period.

D. Comply with applicable laws governing cleaning operations. Remove waste materials from site and dispose of lawfully.

END OF SECTION

SECTION 01 77 00 - CLOSE-OUT PROCEDURES

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 CONTRACT CLOSEOUT PROCEDURES

A. When Contractor considers the work is substantially complete, he shall submit to Engineer a written notice that the Work, or designated portion thereof, is substantially complete, and a list of items to be completed or corrected.

B. Within a reasonable time after receipt of such notice, Engineer and Engineer, as appropriate, will make an inspection to determine the status of completion.

C. Should Engineer determine that the Work is not substantially complete, Engineer will promptly notify the Contractor in writing, giving the reasons therefore.

D. Contractor shall remedy the deficiencies in the Work and send a second written notice of substantial completion to the Engineer.

E. Engineer, as appropriate, will re-inspect the Work.

F. When Engineer concur that the Work is substantially complete, the Engineer will:

1. Prepare a Certificate of Substantial Completion AIA form G704, accompanied by Contractor's list of items to be completed or corrected, as verified and amended by the Engineer.

2. Submit the Certificate to Owner and Contractor for their written acceptance of the responsibilities assigned to them in the Certificate.

1.2 FINAL COMPLETION:

A. When Contractor considers the Work is complete, he shall submit written certification that he has:

1. Reviewed the Contract Documents.

2. Inspected the Work for compliance with Contract Documents.

3. Completed the Work in accordance with Contract Documents or describe in detail, work remaining to be completed and when it will be complete and ready for inspection.

4. Tested equipment and systems in the presence of the Owner's representative and equipment and systems are operational.

5. Performed final clean-up.

6. Submitted required test reports.

7. Delivered all keys to Owner.

8. Delivered all operating tools, replacement items, and "attic stock" materials specified, to Owner.

9. Delivered all required certificates and guarantees to Owner including, but not limited to, signed-off permits, final inspections, and framed Certificate of Occupancy (suitable for wall hanging), by local authorities having jurisdiction, evidence of payment and release of liens as required by General Conditions and Certificate of Insurance for Products and Completed Operations.

10. Submitted all Record Drawings as specified hereinafter.

B. Engineer, as appropriate, will make an inspection to verify the status of completion with reasonable promptness after receipt of such certification.

C. Should either Engineer consider that the Work is incomplete or defective:

1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.

2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to Engineer that the Work is complete

3. Engineer, as appropriate, will re-inspect the Work.

D. When the Engineer, as appropriate, find that the Work is acceptable under the Contract Documents, the Engineer will request the Contractor to make closeout submittals.

E. Refer to Supplementary Conditions, Article 3.

1.3 FINAL CLEAN-UP:

A. Prior to final inspection and the Owner's acceptance of the Work, clean all areas of the building and Project Site, performing all operations called for in the various Sections of these Specifications. These operations include, but are not limited to:

1. Cleaning of all walls and floors.

2. Broom cleaning all exposed concrete floors.

3. Cleaning of all glass areas.

4. Cleaning all exposed unpainted metals.

5. Removing all trash and debris of every nature from the Site and providing legal disposal.

6. Cleaning all exposed surfaces including lenses of all lighting fixtures, removing construction dust, paint over-spray and hand prints.

7. Removing all surplus materials, tools not in active use, scaffolding, and other materials no longer needed.

8. Vacuuming all carpeted floors.

9. Cleaning, waxing, buffing of resilient flooring.

B. All cleaning operations shall be performed in strict accordance with manufacturer's written recommendations using products approved by the manufacturer for the materials being cleaned.

PART 2 – SUBSTANTIAL COMPLETION

2.1 MANUALS, INSTRUCTIONS AND KEYS

A. OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS: Prior to and as a requisite for Owner's acknowledgment of Substantial Completion, required equipment maintenance manuals and operating instructions shall be submitted to the Engineer for transmittal to Owner.

1. Provide manuals in "hard cover" three-ring binders, indexed, and include plans, elevations, isometrics as necessary, manufacturer's catalogs, and other instructions to clearly indicate operation and function of the systems.

2. Include manufacturer's standard information and data, edited or modified to identify the equipment actually furnished and installed.

3. In addition to the above, include the following information:

a. Manufacturer's identification including model number and serial number.

b. Valve list and directory; wiring and piping diagrams.

c. Spare parts list, a list of recommended stock of parts, and location of local parts and service centers.

d. Complete wiring diagrams.

e. Performance data and rating tables.

f. Specific instructions and operation, adjustment, and maintenance.

4. Organize and assemble each manual with a title sheet directly following the front cover listing the Project title and address, name of Owner, and date of submittal. Immediately after the title sheet include a second page listing the name, address, and phone number of the Engineer, General Contractor, Subcontractors, material suppliers and vendors.

5. Categorize the contents of the manuals with separation sheets having labeled tabular edges, and sequence information in the same order and relationship as in the Project Manual.

6. Furnish a letter to Engineer stating that a responsible representative of the Owner (give name and position) has been instructed and informed of working characteristics of mechanical and electrical installations, as required under the Specification Sections, and that necessary verbal instructions and demonstrations shall be given to maintenance forces for component parts of the building.

B. Upon completion of the Work, the Contractor shall deliver all keys, including master keys and any special keys, and two copies of the keying schedule to the Owner, and shall assist the Owner in reactivation of construction keyed locks used in the Project.

2.2 RELEASE OF LIENS

A. The Contractor shall deliver to the Engineer a blanket release of liens covering all Work performed under this Contract, including that of Subcontractors, Sub-subcontractors, vendors, an other suppliers of materials and labor. Execute the release of liens on Documents similar to AIA Document G706 "Contractor's Affidavit of Payment of Debtors and Claims" and AIA Document G706A "Contractor's Affidavit of Release of Liens".

B. The forms shall be executed by the authorized officer and notarized. All required attachments shall be included as noted on AIA Document G706 or Document G706A, the Contractor shall furnish bond satisfactory to the Owner for each exception.

2.3 GUARANTEES, BONDS AND INSPECTION CERTIFICATES

A. The Contractor shall have guarantees upon materials and workmanship as required by the General Conditions and special guarantees and bonds required by the Contract Documents executed in the Owner's name.

B. Prior to making application for final payment, the Contractor shall collect and assemble all required guarantees and bonds and deliver them to the Engineer for review and for transmitting to the Owner.

C. The Contractor shall collect and assemble all required certificates of inspection, testing, and approval, and deliver them to the Engineer for review and for transmitting to the Owner.

2.4 RECORD DOCUMENTS

A. Prior to and as requisite for Owner's acknowledgment of Substantial Completion, submit Project Record Documents to the Engineer for the permanent Project file as follows:

1. Mark changes on a set of record Vellums reproductions. Submit all Record Drawings, mechanical, plumbing, and electrical installations, and other installations as specified in the Contract Specifications. Provide "as-built" drawings changes prepared by an experienced draftsman and showing all components as actually fabricated and erected.

a. Show depths of various elements in relation to Ground Floor elevation.

b. Show horizontal and vertical location of underground utilities and other improvements referenced to permanent surface improvements.

c. Show location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.

d. Indicate field changes of dimension and detail, changes made by field order of Change Order, and details not on original Contract Drawings.

2. Provide Record Drawings signed and dated by the subcontractors. By signing of drawings, subcontractors shall indicate that they have been checked and that they represent a true and accurate record of the work installed.

    a. Provide a cover sheet for each set of Record Documents indicating the Project title and location, the name and address and phone number of Owner, Engineer, Contractor, and all Subcontractors, and the date submitted.

3. Log of all control and survey work as it progresses.

PART 3 – EXECUTION

3.1 TERMINAL INSPECTION

A. Immediately prior to expiration of the one-year guarantee period, the Contractor shall make an inspection of the Work in the company of the Engineer and the Owner. The Engineer and the Owner shall be given not less than 5 days notice prior to the anticipated date of terminal inspection.

B. Where any portion of the Work has proven to be defective and requires replacement, repair or adjustment, the Contractor shall immediately provide materials and labor necessary to remedy such defective Work and shall execute such Work without delay until completed to the satisfaction of the Engineer and the Owner, even though the date of completion of the corrective work may extend beyond the expiration date of the guarantee period.

C. The Contractor shall not be responsible for correction of Work which has been damaged because of neglect or abuse by the Owner nor the replacement of parts necessitated by normal wear in use.

3.2 WARRANTIES

A. Furnish written Warranties to the Owner including specific items in each product warranty stipulated in the individual sections.

B. Secure and transmit required Inspection Certificates.

C. Repair or replace damaged portion of the construction, under Warranty, when damages result from faulty materials or negligent workmanship.

D. Warrant that modifications or substitutions suggested by the Contractor will give satisfactory results, and that they will be equal or superior to the specified item or method unless shortcomings are specifically listed in the request for modification or substitution.

END OF SECTION

SECTION 01 78 23 - OPERATION AND MAINTENANCE MANUALS

CONDITIONS OF THE CONTRACT, AND DIVISION 1 SECTIONS APPLY TO THIS SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Refer to Section AB – Instructions to Proposers and Section AF – Manufacturer Prequalification for substitutions.

B. Scope of Work:

1. Compilation product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare operating and maintenance data as specified.

2. Instruct Owner's personnel in operation and maintenance of equipment and systems.

3. Submit three copies of complete manual in final form.

C. All Operation and Maintenance Manuals MUST be submitted to the Owner in their reviewed, accepted final form PRIOR to any Owner demonstrations.

1.2 SUBMITTALS

A. Initial Submittal: Submit to A/E consultant, as applicable, one (1) review / draft copy of each Operating and Maintenance Manual.

1. Submit directly to the reviewing consultant (architectural, MEP, Structural, Civil, Food Service, etc.); with a copy of the transmittal delivered to the Engineer.

2. The A/E consultant shall return review comments or approval of each O&M manual submission within twenty-one (21) days.

B. If a manual is deemed to be incomplete or contain errors, Contractor shall retrieve the review / draft copy and make all necessary corrections. Once complete, resubmit the complete, correct manual for A/E review.

C. Repeat the above process as necessary to obtain final A/E approval of each O&M manual.

D. Final Submittal: When O&M manuals have been reviewed and approved for final printing and distribution, submit two (2) complete sets of O&M manuals to Engineer; and two (2) CD’s containing PDF files of each O&M manual. Engineer shall deliver final O&M manuals to the Owner.

E. This copy shall contain as a minimum:

1. Table of Contents for each element.

2. Contractor information for each contractor / sub-contractor.

3. All submittals, coordination drawings and product data, reviewed by the Engineer; bearing the Engineer's stamp of acceptance. (When submittals are returned from Engineer "Correct as Noted", corrected inserts shall be included.)

4. All parts and maintenance manuals for items of equipment.

5. Warranties (without starting dates)

6. Certifications that have been completed. Submit forms and outlines of certifications that have not been completed.

7. Operating and maintenance procedures.

8. Form of Owner's Training Program Syllabus (including times and dates).

9. Control operations/equipment wiring diagrams.

10. Schedule of filters for each item of equipment.

11. Schedule of belts for each item of equipment.

12. Other required operating and maintenance information that are complete.

1.3 QUALITY ASSURANCE

A. It is the Contractor’s / sub-contractor’s responsibility to compile, review and verify that Operations and Maintenance Manuals are 100% complete and correct in accordance with the specified requirements prior to submission to the Engineer for review.

1. Failure to comply with required verification may result in return of O & M manuals without a thorough A/E review.

B. Once submitted to the Engineer for review, the A/E shall review and return any comments and revisions for correction to be incorporated into the final manuals.

C. Schedule for Submission and Delivery:

1. Submit O&M Manuals for review far enough in advance to assure completion of review(s), correction(s), publication of the final O&M manuals, and delivery to the Owner PRIOR to any Owner demonstrations / training involving equipment / systems included in the manual(s).

2. No Owner demonstrations / training shall occur without final, approved O&M manuals have been delivered to the Owner.

PART 2 - PRODUCTS

2.1 BINDERS

A. Commercial quality black three-ring binders with clear overlay plastic covers on front and spine.

B. Binders shall be a minimum ring size: 1", and a maximum ring size: 3".

C. When multiple binders are used, correlate the data into related groupings.

D. Label contents on spine and face of binder with full size insert. Label under plastic cover.

2.2 CONTENT

A. Each O&M manual shall include as a minimum the following material and information:

1. Table of Contents for each element, including corresponding specification number.

2. Contractor information for each contractor / sub-contractor.

3. All submittals, coordination drawings and product data, reviewed by the Engineer; including the Engineer's stamp of acceptance / review comment sheets. When submittals are returned from Engineer "Correct as Noted", corrected inserts shall be included.

4. All parts and maintenance manuals for items of equipment.

5. Warranties (without starting dates)

6. Certifications that have been completed. Submit forms and outlines of certifications that have not been completed.

7. Operating and maintenance procedures.

8. Control operations / equipment wiring diagrams.

9. Schedule of filters for each item of equipment.

10. Schedule of belts for each item of equipment.

11. Material Safety Data (MSD) sheets

12. Other required operating and maintenance information that are complete.

B. All material will be bound in the 3-ring binder unless otherwise agreed to by the Engineer.

1. Sheets that are 8-12 x 14 or 11 x 17 shall be folded to an 8-1/2 x 11 format.

PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE MANUAL

A. Form for Manuals:

1. Prepare data in form of an instructional manual for use by Owner's personnel.

2. Format:

a. Size: 8-1/2" x 11".

b. Text: Manufacturer's printed data or neatly typewritten.

3. Drawings:

    a. Provide reinforced punched binder tab and bind in text.

    b. Fold larger drawings to size of text pages.

4. Provide flyleaf indexed tabs for each separate product or each piece of operating equipment.

5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:

    a. Title of Project

    b. Identity of separate structures as applicable.

    c. Identity of general subject matter covered in the manual.

6. Binder as specified.

B. Content of Manual:

1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.

    a. Contractor, name of responsible principal, address and telephone number.

    b. A list of each product required to be included, indexed to content of the volume.

    c. List with each product, name, address and telephone number of:

        1) Subcontractor or installer.

        2) Maintenance contractor as appropriate.

        3) Identify area of responsibility of each.

        4) Local source of supply for parts and replacement.

    d. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

2. Product Data:

    a. Include those sheets pertinent to the specific product.

    b. Annotate each sheet to:

        1) Identify specific product or part installed.

        2) Identify data applicable to installation.

3) Delete references to inapplicable information. (All options not supplied with equipment shall be marked out indicated in some manner.

3. Drawings:

a. Supplement product data with drawings as necessary to illustrate:

1) Relations of component parts of equipment and systems.

2) Control and flow diagrams.

b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.

c. Do not use Project Record Documents as maintenance drawings.

4. Written text, as required to supplement product data for the particular installation:

a. Organize in consistent format under separate headings for different procedures.

b. Provide logical sequence of instructions for each procedure.

5. Copy of each warranty, bond and service contract issued.

a. Provide information sheet for Owner's personnel, giving:

1) Proper procedures in event of failure.

2) Instances that might affect validity of warranties or bonds.

6. Shop drawings, coordination drawings and product data as specified.

C. Sections for Equipment and Systems:

1. Content for each unit of equipment and system as appropriate:

a. Description of unit and component parts.

1) Function, normal operating characteristics, and limiting conditions.

2) Performance curves, engineering data and tests.

3) Complete nomenclature and commercial number of replaceable parts.

b. Operating procedures:

1) Start up, break-in, routine and normal operating instructions.

2) Regulation, control, stopping, shut down and emergency instructions.

3) Summer and winter operating instructions.

4) Special operating instructions.

c. Maintenance procedures:

1) Routine operations

2) Guide to trouble-shooting.

3) Disassembly, repair and reassembly.

4) Alignment, adjusting and checking.

5) Routine service based on operating hours.

d. Servicing and lubrication schedule. List of lubricants required.

e. Manufacturer's printed operating and maintenance instructions.

f. Description of sequence of operation by control manufacturer.

g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.

1) Predicted life of part subject to wear.

2) Items recommended to be stocked as spare parts.

h. As installed control diagrams by controls manufacturer.

i. Complete equipment internal wiring diagrams.

j. Schedule of filters for each air handling system.

k. Schedule of belts for each item of equipment.

l. Each Contractor's coordination drawings.

m. As installed color coded piping diagrams.

n. Charts of valve tag number, with location and function of each valve.

o. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.

p. Other data as required under pertinent sections of the specifications.

2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.

3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications.

4. Provide complete information for products specified in Division 22.
5. Provide certificates of compliance as specified in each related section.
6. Provide start up reports as specified in each related section.
7. Provide signed receipts for spare parts and material.
8. Provide training report and certificates.
9. Provide backflow preventer certified test reports.
10. Provide gas piping pressure test reports.

END OF SECTION

SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes general requirements that apply to implementation of the commissioning process without regard to systems, subsystems, and equipment being commissioned.

B. Commissioning is systematic process to provide documented confirmation the building systems perform according to the criteria set forth in the design documents and satisfy the Owner's Project Requirements and the facility's operational needs.

C. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.

2. Verify and document proper performance of equipment and systems.

3. Verify that O&M documentation provided to the Owner and is complete.

4. Verify that the Owner's operating personnel are adequately trained.

D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1. Related Sections include, but not limited to the following:

a. Section 22 08 00 - Commissioning of Plumbing Systems

b. Section 23 08 00 - Commissioning of HVAC Systems

c. Section 23 09 63 - Energy Management and Control System (EMCS)

d. Section 26 08 00 - Commissioning of Electrical Systems

E. Owner's Project Requirements (OPR) and Basis of Design (BOD) documentation are included by reference for information only.

F. The specified commissioning process shall be performed by an impartial technical firm hired by the owner. The commissioning firm shall be certified under one or more of the following certifications:

G. CxA - Certified Commissioning Authority - ACG

H. CBCP - Certified Building Commissioning Professional - AEE

I. CCP - Certified Commissioning Professional - BCA

J. CPMP - Certified Process Management Professional - ASHRAE

K. BSC - Building System Commissioning Certification - NEBB

L. The commissioning firm (Commissioning authority) shall be responsible for leading the entire construction team through the commissioning process including, but not limited to, conducting the commissioning kick-off meeting, preparing the commissioning plan, preparing pre-functional checklists, preparing functional test scripts, participation in functional testing and preparation of required documentation and reports.

1.2 DEFINITIONS

A. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to Contract Documents.

B. Basis of Design: Documentation of primary thought processes and assumptions behind design decisions that were made to meet design intent and satisfy applicable regulatory requirements, standards, and guidelines. Describes systems, components, conditions, and methods chosen to meet intent. The document includes both narrative descriptions and lists of individual items that support the design process.

C. Building Commissioning: A joint team effort to ensure that all mechanical equipment, controls, and systems function together properly to meet the design intent, to document system performance parameters and to ensure that personnel are adequately trained to operate systems.

D. Commissioning Authority: The independent commissioning provider, hired by the owner that will oversee the entire commissioning process.

E. Commissioning Process (Cx): A process which coordinates the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, training and performance testing. Commissioning requirements do not supersede other requirements of the specifications, but may expand on some of them.

F. Commissioning Agent (CxA): Independent agent hired by Owner. Under Owner’s direction, and not Contractor’s direction, CA will direct and coordinate day-to-day commissioning activities without assuming oversight responsibilities.

G. Commissioning Team: Consists of Commissioning Agent, the Owner or Owner's Representative, Design Team, Contractors, Subcontractors, and Vendors.

H. Owner’s Project Requirements (OPR): A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

I. Functional Performance Test (FPT): Test of the function of systems, as opposed to components, under full operation in various modes through all control system’s sequences of operation using manual (direct observation) or monitoring methods following prescribed test procedures in sequential written form.

J. Pre-Functional Checklist (PFC): Checklist provided by Commissioning Agent, of items to inspect and elementary component tests to conduct to verify proper installation of equipment prior to functional testing.

K. Sampling: Functionally testing only a fraction of total number of identical or near identical pieces of equipment.

L. Seasonal Testing: Testing of equipment which can be done only during periods of peak heating or cooling, when HVAC equipment is operating at full-load or heavy-load conditions.

M. Simulated Condition: Condition created for purpose of testing response of system.

N. Trending: System monitoring using the Building Automation System.

1.3 RESPONSIBILITIES

A. The Commissioning Agent: Responsibilities of the CxA include, but are not limited to the following:

1. Coordinate and direct each step of the Commissioning Process for systems being commissioned for this project. Coordinate commissioning work schedule with Project Manager and Contractor.

2. Attend planning and job-site meetings as required to obtain information relating to Commissioning Process.

3. Plan and conduct commissioning scoping and coordination meetings. Provide notice to all Team members to attend scheduled commissioning meetings.

4. Ensure all information required for Commissioning Process from manufacturers, Contractors, and A/E design team is available.

5. Review A/E design documents to gain clear understanding of design intent.

6. Review Contractor submittals for compliance with commissioning needs.

7. Verify that systems and equipment have been installed and started in accordance with manufacturer’s recommendations and with generally recognized construction standards and that documentation of such has been provided.

8. Prepare Pre-Functional Checklists to ensure systems have been installed according to project specifications. Verify that Pre-Functional Checklists have been completed by Contractor and are accurate.

9. Prepare Functional Testing procedures to demonstrate performance of systems according to project specifications. Observe and document performance of systems, as per process detailed in Functional Test procedures.

10. Review Testing and Balancing (TAB) reports, notify Owner of deficiencies.

11. Recommend acceptance or non-acceptance of systems to Owner.

12. Verify that Operations and Maintenance (O&M) documentation is acceptable. Operations and Maintenance manuals shall be submitted simultaneously to CxA and to Design Professionals for review.

13. Verify that Owner training is completed for all systems to be commissioned.

14. Compile and maintain commissioning record.

15. Provide final Commissioning Report to Owner.

16. Prepare and maintain commissioning “Issues Log”.

B. Contractor: Responsibilities of the Contractor as relate to Commissioning Process include, but are not limited to the following:

1. Facilitate coordination of commissioning work by CxA.

2. Attend Commissioning meetings or other meetings called by CxA to facilitate the Commissioning Process.

3. Review Functional Testing procedures for feasibility, safety, and impact on warranty, and provide CxA with written comment on same.

4. Provide all documentation relating to manufacturer’s recommended performance testing of equipment and systems.

5. Provide Operations and Maintenance Data to CxA for preparation of checklists and training manuals.

6. Provide testing and balancing report.

7. Assure and facilitate participation and cooperation of subcontractors (electrical, mechanical, controls, etc.) and equipment suppliers as required for the Commissioning Process.

8. Certify to CxA that installation work listed in Pre-functional Checklists has been completed.

9. Install systems and equipment in strict conformance with project specifications, manufacturer’s recommended installation procedures, and Pre-Functional Checklists, as prepared by CxA.

10. Provide data concerning performance, installation, and start-up of systems.

11. Provide copy of manufacturer’s filled-out start-up forms for equipment and systems.

12. Ensure systems have been started and fully checked for proper operation prior to arranging for Functional Testing with CxA. Prepare and submit to CxA **written** certification that each piece of equipment and/or system has been started according to manufacturer’s recommended procedure, and that system has been tested for compliance with operational requirements.

a. Contractor shall carry out manufacturer's recommended start-up and testing procedures, regardless of whether or not they are specifically listed in Functional Test procedures.

b. Contractor is not relieved of obligation for systems/equipment demonstration where performance testing is required by specifications, but a Functional Performance Test is not specifically designated by CxA.

c. Submit Certification of Readiness to CxA to show equipment/system has been reviewed and is ready for functional testing.

13. Coordinate with CxA to determine mutually acceptable date of Functional Performance Tests.

14. Provide test instruments and communications devices, as prescribed by CxA, required for carrying out Functional Testing of systems.

15. Ensure deficiencies found in the Commissioning Process are corrected within the time schedule shown in the CA report.

16. Provide CxA with all submittals, start-up instructions manuals, operating parameters, and other pertinent information related to Commissioning Process. This information shall be routed through Architect.

17. Prepare and submit to CxA proposed Training Program outline for each system.

18. Coordinate and provide training of Owner's personnel.

19. Prepare Operation and Maintenance manuals and As-Built drawings in accordance with specifications; submit copy to CxA in addition to other contractually required submissions. Revise and resubmit manuals in accordance with A/E and CxAs comments.

20. All costs associated with the participation of Contractor, Sub-Contractors, Design Professionals, and Equipment Vendors in the Commissioning Process shall be included in the scope of this contract.

21. Provide written response to resolution of items listed in "Issue Log".

C. Subcontractors and vendors shall prepare and submit to Commissioning Agent proposed Pre-Functional and Functional Performance Test procedures to demonstrate performance of systems according to these specifications and checklists prepared by Commissioning Agent.

D. Owner's Representative: Responsibilities of the Owner's Representative as related to Commissioning Process include, but are not limited to the following:

1. Manage contracts of Architect and Contractor.

2. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.

3. Provide final approval for completion of commissioning Work.

4. Warranty Period: Ensure that seasonal or deferred testing and deficiency issues are addressed.

E. Architect: Responsibilities of the Architect as related to the Commissioning Process shall include, but are not limited to the following:

1. Attend commissioning scoping meeting and other commissioning team meetings as requested by Commissioning Agent and as selected by Architect.

2. Perform normal submittal review, construction observation, record drawing preparation, and operations and maintenance data preparation, as required by Contract Documents.

3. Provide design narrative documentation requested by Commissioning Agent.

4. Coordinate resolution of system deficiencies identified during commissioning, as required by Contract Documents.

5. Prepare and submit final as-built design intent documentation for inclusion in Operation and Maintenance Data Manual, and review and approve Operation and Maintenance Data Manual.

6. Warranty Period: Coordinate resolution of design non-conformance and design deficiencies identified during warranty period commissioning.

F. Mechanical, Electrical, and Plumbing Engineers: Responsibilities of the Engineers as related to the Commissioning Process shall include, but are not limited to the following:

1. Perform normal submittal review, construction observations, and record drawing preparation, as required by Contract Documents. Perform site observation immediately preceding system startup.

2. Provide design narrative and sequence documentation requested by Commissioning Agent. Assist, along with Contractor, in clarifying operation and control of commissioned equipment in areas where specifications, control drawings, or equipment documentation are not sufficient for writing detailed testing procedures.

3. Attend commissioning scoping meetings and other commissioning team meetings as requested by Commissioning Agent and as selected by Architect or responsible design professional.

4. Participate in resolution of system deficiencies identified during commissioning, as required by Contract Documents.

5. Prepare and submit final as-built design intent and operating parameters documentation for inclusion in Operation and Maintenance Manual, and review and approve Operation and Maintenance Manual.

1.4 COMMISSIONING PLAN

A. Commissioning Process tasks and activities:

1. Commissioning kick-off meeting: Conducted by commissioning authority and attended by construction team and design team.

2. Pre-functional checklists: Prepared by the commissioning authority and filled out by subcontractors performing the work that is applicable.

3. Site visits to review installation of applicable systems and progress of checklist documentation performed and reported by commissioning authority.

4. Functional testing: Commissioning authority shall conduct functional testing with assistance of applicable subcontractors and document successful results as well as deficiencies (issues). Functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing in accordance with plans and specifications. Testing shall include all modes and sequence of operation, including under full-load, part-load and emergency conditions (including all alarms). Controls system shall be tested to document that control devices, components, equipment and systems are calibrated and adjusted and operate in accordance with the plans and specifications. Sequences shall be functionally tested to document they operate in accordance with plans and specifications.

5. Preliminary commissioning report: Commissioning authority shall issue a preliminary commissioning report to the owner that has results of the first round of functional testing including deficiencies discovered.

6. Air and hydronic system balancing: Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the contract documents. System balancing shall be performed by T.A.B. contractor as specified in 23 05 93 - Testing, Adjusting, And Balancing.

7. Systems manual: Commissioning authority shall compile the systems manual using submittal data provided by the general contractor and applicable subcontractors.

8. Final commissioning report: Commissioning authority shall issue final commissioning report documenting the entire process and final results of functional testing. Report shall include final testing and balancing report.

B. Mechanical System equipment to be tested

1. Energy Management and Control System:

a. Graphical User Interface

b. Automation Software

c. Field Level Controllers

d. Field Level Devices

e. Control Sequences

2. Chilled Water Systems (All chillers and pumps)

3. Condenser Water Systems (All towers and pumps)

4. Heating Water Systems (All boilers and pumps)

5. Air Handling Systems (All AHU and 10% of terminal units)

6. Energy Recovery Systems (100%)

C. Electrical System Equipment to be tested

1. Occupant sensor controls

2. Time switch controls

3. Daylight responsive controls

4. Electrical distribution system

5. Automatic receptacle controls

D. Plumbing System Equipment to be tested

1. Energy Management and Control System interface with applicable plumbing system equipment

2. Service water heating systems (100%).

3. Service water heating circulation equipment (100%).

4. Domestic water booster pumps (100%).

5. Water Treatment Systems (Verify vendor's completion of scope)

E. Testing functions and conditions

1. Energy conservation programs (economizer, optimal start, etc.).

2. Verify shutdown of systems when scheduled.

3. Calibration of sensors.

4. Testing shall affirm winter and summer design conditions.

5. Test under full outside air conditions.

6. Confirm functionality of all specified sequences of operations.

7. Verify the functionality of all alarms.

8. Verify daylighting control devices have been calibrated, properly located, adjusted and respond as specified.

9. Verify time switch schedule, time, date and programming is accurate. Verify override time limit is set, battery is installed and switch operates the lights that are specified in the design documents.

10. Verify that occupant sensor has been located and aimed in accordance with manufacturer instructions. Testing shall be done for each unique combination of sensor type and space geometry.

11. Document the ground resistance testing performed by contractors.

12. Document electrical subcontractor has adjusted breakers to setting recommended by coordination study.

13. Document that any required infrared studies are performed.

14. Document testing of transformer insulation and voltage drop.

15. Document any other testing requirements have been fulfilled as required within

F. Performance criteria

1. Air and water temperatures shall be within tolerances specified in the contract documents.

2. Space temperatures shall be maintained within 1 degree of specified set points.

3. Space humidity shall be maintained within 5% of specified levels.

4. Heating water recovery shall be within specified time frame and temperature.

5. Daylighting controls shall maintain specified light levels within 5% of design.

6. All time switches shall be accurate to time on cellular network devices.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall coordinate with sub-Contractors and equipment vendors/representatives to set aside adequate time to address Pre-Functional Testing, Functional Testing, Operations and Maintenance Training, and associated coordination meetings.

B. CxA may also conduct site inspections at critical times and issue Cx Field Reports with observations on installation deficiencies so that they may be issued by Architect as deemed appropriate.

3.2 MEETINGS

A. A commissioning team scoping meeting shall be held at a time and place agreed upon shortly after the beginning of the construction phase of the project. Owner, Commissioning Agent, General Contractor, Architect, Mechanical Subcontractor, and Electrical Subcontractor shall be present at this meeting. The purpose of the meeting is to familiarize all parties with the requirements of the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

B. Separate meetings including individual equipment suppliers and subcontractors shall be held prior to commissioning of their systems at the discretion of CxA.

C. Miscellaneous Meetings. The CxA shall plan and conduct other meetings as required as construction progresses. Meetings will cover coordination, deficiency resolution, and planning issues with particular subcontractors. CxA will plan meetings to minimize unnecessary time being spent by subcontractors.

3.3 PRE-FUNCTIONAL CHECKLISTS (PFC)

A. General

1. Pre-functional checklists are important to ensure that equipment and systems are properly connected and operational, and installed in accordance with specifications, drawings, manufacturer's requirements, and all applicable codes.

2. Checklists ensure that functional performance testing (in-depth checkout) may proceed without unnecessary delays.

3. Performance of pre-functional checklists, startup, and checkout shall be directed and executed by subcontractor or vendor. Only individuals that have direct knowledge and who witnessed that line item task on pre-functional checklist was performed shall initial or check item off.

4. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used.

5. Pre-functional checkout for given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of given system.

B. Pre-Functional Checklist

1. Pre-functional performance tests shall be documented in a checklist format, as prepared and provided by CxA, for each piece of equipment. Each checklist shall be initialed by Contractor.

2. Commissioning Pre-functional checklists are not to preclude Contractor from applying his own construction inspection checklists.

3. All system elements shall be checked to verify that they have been installed, adjusted, and calibrated properly, that all connections have been made correctly, and that it is ready to function as specified. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, control sequence, and other conditions which may cause damage.

4. Verify that tests, meter readings and specific electrical characteristics agree with those required by equipment or system manufacturer.

5. All discrete elements and sub-systems shall be adjusted and shall be checked for proper operation. Verify wiring and support components for equipment are complete and tested.

6. Conduct start-up procedure recommended by equipment/system manufacturer.

7. Subcontractors shall clearly list outstanding items of initial start-up and pre-functional procedures that were not completed successfully at bottom of procedures form or on separate sheet attached to form. Completed form and attached sheets shall be provided to Commissioning Agent within 2 days of test completion. Installing subcontractor or vendor shall correct deficient or incomplete areas in timely manner and shall submit updated pre-functional checklist and startup report with statement of correction on original non-compliance report.

3.4 SYSTEM START-UP

A. Contractor will arrange for start-up of operating equipment and systems prior to scheduling Functional Testing.

B. Start-up of equipment and systems shall be performed only by a manufacturer's representative, or person(s) who are specifically manufacturer-approved. All start-up personnel shall be trained and authorized, experienced and knowledgeable in the operations of such equipment and systems.

C. Coordinate schedule for start-up of various equipment and systems so that subsystems required for major systems operation are tested first.

D. Manufacturer's start-up reports must be submitted to CxA prior to scheduling Functional Testing.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. General

1. The objective of Functional Testing is to demonstrate that each system is operating according to documented design intent and Contract Documents, through all possible modes of operation.

2. Contractor and sub-Contractors shall include in his bid proposal all costs associated with preparation and execution of Testing Procedures.

3. Functional Testing is intended to begin upon completion of each system. Functional Testing may proceed prior to completion of systems or sub-systems at discretion of Commissioning Agent and Construction Administrator. Beginning system testing before completion, does not relieve Contractor from fully completing system, including pre-functional checklists as early as possible.

4. Contractor and sub-Contractors shall provide detailed Testing Procedures that will allow all items on checklists to be verified.

5. Testing shall be conducted under specified operating conditions as recommended or approved by Commissioning Agent.

6. A Functional Performance Test shall be performed on each complete system. Each function shall be demonstrated to the satisfaction of Commissioning Agent in accordance with proposed test procedures developed to demonstrate compliance with specifications.

7. Each Functional Test shall be witnessed and signed off by Owner and Commissioning Agent upon satisfactory completion.

8. All elements of system shall be tested to demonstrate that total systems satisfy all requirements of these specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each subsystem, followed by the entire system, followed by any inter-ties to other major systems.

9. All major testing materials and equipment shall be provided by contractor.

B. Notification, Scheduling of Functional Testing and Re-Testing

1. Notify CxA and Owner, in writing, of request for scheduling Functional Testing. Submit request no fewer than five business days prior to desired day of testing.

    a. Contractor must certify that systems and equipment are functioning satisfactorily, according to specifications and design intent, prior to requesting Functional Testing by submitting a certification or readiness. Upon receipt of such certification, CxA will schedule with Contractor a time for the particular system test.

    b. CxA will attempt to schedule Functional Testing when convenient for Contractor and his vendors.

    c. Contractor will resolve all deficiencies identified during initial test prior to submitting request, in writing, for re-testing. Such request for re-testing shall certify that Contractor has resolved all deficiencies, or list reason why any deficiencies remain which cannot be resolved.

    d. CxA will re-test to ensure that all deficiencies have been resolved.

e. Deficiencies that were not detected in first Functional Test, but are discovered in subsequent re-testing, are to be resolved by Contractor as if they had been discovered in initial testing.

C. Functional Testing Requirements and Procedures

1. Contractor and Subcontractors shall perform tests in the presence of CxA. Tests not witnessed by CxA shall not be considered complete.

2. To facilitate Functional Testing, when requested by CxA, Contractor shall provide services of personnel to accompany CxA for the duration of Functional Testing, including any follow-up testing. Such personnel must be experienced, qualified, and intimately familiar with the system being tested.

a. Participation by representative(s) of the Building Automation Contractor is of particular importance in Functional Testing. All systems which are controlled and / or monitored by BAS are to be thoroughly tested, point by point, through all modes of operation, with the assistance of the Contractor's representative. Graphics, setpoints, and programming are to be included as a part of Functional Testing as well.

b. Contractors must provide services of personnel to accompany CxA for equipment and systems which may pose particular health and safety concerns, such as boilers.

c. Should he fail to provide representative to accompany CxA during Functional Testing, Contractor continues to bear full responsibility for equipment warranty. Owner and CxA will not be held responsible for damage to equipment, or other actions which might impact warranty, when performing Functional Testing of systems where Contractor has not provided authorized accompanying representative to operate equipment.

3. Each system shall be operated through all modes of operation including, but not limited to seasonal, occupied, unoccupied, warm-up, cool-down, part-load, and full-load, where system response is specified.

a. For multiple units, sampling strategy established by Commissioning Agent and subject to approval of Construction Administrator may be used.

b. Verification of each sequence in sequences of operation is required.

c. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, and the like, shall also be tested.

4. Functional Testing is to be dedicated solely to testing of equipment and systems, and not to resolution of deficiencies. Deficiencies identified during testing process must be corrected by Contractor at a time other than during Functional Testing.

5. CxA shall issue test reports with readings and checklists and a listing of any deficiencies that must be addressed by Contractor or sub-Contractors.

6. Commissioning Agent shall submit a Final Report to Owner recommending acceptance or non-acceptance of individual system components as well as the systems as a whole.

7. DBR has included a small contingency for limited retesting, however DBR reserves the right to stop testing on a system when the system:

    a. Does not have the correct graphics programmed.

    b. Does not have the correct data trends programmed.

    c. Does not have the correct set points programmed.

    d. Does not have the equipment or system safeties installed and programmed correctly.

    e. The TAB data forms have not been submitted to our firm or the performance of the system listed on the TAB forms is not per project requirements.

    f. Line items of the functional performance test have failed.

8. Sampling

    a. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy.

    b. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in prefunctional checklist execution.

    c. A common sampling strategy is the “xx% Sampling - yy% Failure Rule”, defined by the following example.

        1) xx = the percent of the group of identical equipment to be included in each sample.

        2) yy = the percent of the sample that if failing, will require another sample to be tested.

        3) The example below describes a 20% Sampling - 10% Failure Rule.

            (a) Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample.”

            (b) If 10% (yy) of the units in the first sample fail the functional tests, test another 20% of the group (the second sample).

            (c) If 10% of the units in the second sample fail, test all remaining units in the whole group.

(d) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

4) If a second sampling and a whole group round of testing is required, the commissioning agent will charge the contractor an hourly rate of $150.00 for time and expenses associated with the testing.

D. Re-Testing and Failure to Remedy Deficiencies

1. Despite Contractor's best efforts to ensure systems are problem-free, it is expected that some deficiencies will be found during initial inspection of Pre-functional Checklist, and during initial Functional Testing; such deficiencies are expected to be minimal.

2. It is Contractor's responsibility to remedy identified deficiencies, both in Pre-functional Checklist and in Functional Testing phases of work, in a timely and thorough manner.

3. It is Contractor's responsibility to ensure that all deficiencies are corrected prior to requesting a re-inspection or re-test of systems and equipment. Do not request re-inspection or re-test until deficiencies are corrected.

a. At his discretion, CxA may agree to re-testing systems or equipment where deficiencies remain which are beyond Contractor's control to resolve expeditiously.

b. Typically such re-testing of incomplete systems and equipment will take place only if remaining deficiencies are minor in scope and nature, and are of such nature that they cannot be resolved in a timely manner (such as those due to difficulties in obtaining parts, or where Owner has requested a change that has delayed work, etc.)

4. CxA will carry out a second re-inspection or re-test of systems and equipment subsequent to receiving Contractor's request.

a. If CxA finds deficiencies identified in initial inspection or test have not been remedied (with exception of un-resolvable deficiencies in 3.b. above), and such remaining deficiencies are significant enough to require additional inspection or re-testing, Contractor will be back-charged for CxA's expenses, and time at a rate of $150.00 per hour and $100.00 expenses, for a third and any subsequent re-inspections and re-tests.

E. Deferred Testing

1. Seasonal Commissioning" pertains to testing during peak heating or cooling seasons when HVAC equipment is operating at full-load or heavy-load conditions. Initial commissioning will be done as soon as contract work is completed, regardless of season. Seasonal Commissioning under full- or heavy-load conditions other than the current season will be handled at later time by GC and CxA.

2. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods.

3. GC is to provide services of personnel and participate in seasonal testing process in the same manner as he would in non-seasonal testing.

4. Until off-season commissioning can be accomplished, Owner may retain an amount from GC's payment sufficient to cover the cost of off-season testing.

5. Unforeseen Deferred Tests: If any check or test cannot be completed due to building structure, required occupancy condition, or other reason, execution of checklists and functional testing may be delayed upon approval of Owner. Tests shall be conducted in same manner as seasonal tests, as soon as possible. Services of required parties will be negotiated. Make final adjustments to Operation and Maintenance Manuals and record drawings due to unforeseen deferred tests.

6. GC is to provide services of personnel and participate in deferred testing in the same manner as he would for normal commissioning.

7. Until deferred testing can be accomplished, Owner may retain an amount from GC's payment sufficient to cover the cost of deferred testing.

3.6 TRAINING

A. Scheduling

1. Provide a proposed schedule and outline of training of Owner's personnel for Commissioning Agent's review approximately 30 days before project completion. The Commissioning Agent will review the submittal.

2. Submit revised outline and fully developed training materials for review by Commissioning Agent, 10 business days prior to scheduled training sessions.

3. Organize training to fit Owner's schedule and to optimize the learning experience. Limit continuous sessions to no more than three hours at a time, or otherwise only as approved by Owner and/or Architect/Engineer.

B. Training Materials

1. Develop Training Manuals to meet requirements of individual equipment specification sections.

2. Operating and Maintenance Manuals alone are NOT considered training manuals. O&M Manuals may be used as reference, but shall not be considered to meet requirements for training materials.

3. Develop a detailed outline showing how training program will be organized, including classroom and hands-on training as required by individual specifications sections.

4. Provide with training materials, a quick-reference "how-to" index which will allow operators to easily access information included in Training Manuals and/or O&M Manuals. This reference will include, as a minimum; routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions.

5. Refer to individual equipment or system specifications for minimum material to be covered as part of the training program.

C. Training session agenda

1. The training agenda (plan) shall include, at a minimum, the following elements:

2. Purpose of equipment.

3. Principle of how the equipment works.

4. Important parts and assemblies.

5. How the equipment achieves its purpose and necessary operating conditions.

6. Most likely failure modes, causes and corrections.

7. On site demonstration.

3.7 DOCUMENTATION

A. Commissioning authority shall provide documentation of process as follows:

1. Preliminary commissioning report including test procedures, results of testing, itemization of deficiencies, deferred tests and climatic conditions required for performance of deferred tests. Preliminary commissioning report shall be issued to owner to demonstrate the first pass of testing has occurred and to demonstrate compliance with applicable codes.

2. Final commissioning report shall include the final test and balance report, final results of functional testing, disposition of deficiencies discovered during testing, including the details of corrective measures used and functional testing procedures used for repeatability of testing in the future.

3.8 CERTIFICATE OF READINESS

A. Make copies of attached form to submit for functional testing.

CERTIFICATE OF READINESS

Contractor has verified that the following prerequisite items have been completed in preparation for the functional testing phase of the commissioning process.

System to be Commissioned:_____

☐ The system to be commissioned, including all equipment, ductwork, piping, electrical, plumbing, and interfaces to other systems is complete, installed per the Contract Documents, and any issues previously identified by the Commissioning Team have been addressed.

☐ All equipment has been properly started up by qualified personnel. Where specified, the startup was conducted by the manufacturer. Startup procedures and reports have been documented and provided to the CxA.

☐ All outstanding issues have been addressed.

☐ For HVAC Systems, the Test and Balance work is complete, all issues have been corrected, and a final (draft) report has been provided to the CxA.

☐ For Building Automation system (BAS), the BAS contractor has completed their own checkout procedures, including but not limited to the following:

- Calibration of all sensors.
- Point-to-Point checks of all sensors and devices.
- Checks of all devices (dampers, control valves, etc.) for proper operation, fail position, and verification of no leakage.
- Programming of all sequences of operations, alarms, and setpoints.
- Completion and check of all graphics.
- Interface with other systems (lighting, plumbing, metering, etc.)

☐ All equipment and systems are online and operating with no restrictions for testing.

☐ All necessary notifications, coordination and scheduling have been considered that might be required for functional testing of this system (e.g. Owner, Fire Marshal, Occupants, etc.)

Attach a list of any known exceptions or outstanding issues related to the above statements.

List name, title, company, date: _____

I have verified that the above statements are true and that the system is ready for functional testing by the CxA, except for those items noted as attached. I understand that if it is found that the system has not been properly prepared as per the above, necessitating one or more return site visits by the CxA, the Construction Team may be charged by the Owner for the cost of the trip, set at $250/hr including travel time plus travel expenses.

Signature: _____

END OF SECTION

SECTION 23 02 00 - BASIC MATERIALS AND METHODS FOR HVAC

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all Work herein.

B. The Contract Drawings indicate the extent and general arrangement of the systems. If any departure from the Contract Drawings is deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted to the Architect/Engineer for review as soon as practicable. No such departures shall be made without the prior written approval of the Architect/Engineer.

C. Notwithstanding any reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, such reference shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect/Engineer, expressed in writing, is the equivalent of that specified.

1.2 SCOPE OF WORK

A. The Work included under this Contract consists of the furnishing and installation of all equipment and material necessary and required to form complete and functioning systems in all of their various phases, all as shown on the accompanying Drawings and/or described in these Specifications. The Contractor shall review all pertinent drawings, including those of other contracts, prior to commencement of Work.

B. This Division requires the furnishing and installing of all items as specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.

C. The approximate locations of Mechanical (HVAC) items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.

D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

E. Any discrepancies within the Contract Documents or between the Contract Documents and actual job-site conditions shall be reported to the Owner or Engineer so that they will be resolved prior to bidding. Where this cannot be done at least seven (7) working days prior to bid, the greater or more costly of the discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.

F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.

G. It is the intent of the above "Scope" to give the Contractor a general outline of the extent of the Work involved; however, it is not intended to include each and every item required for the Work. Anything omitted from the "Scope" but shown on the Drawings, or specified later, or necessary for a complete and functioning heating, ventilating and air conditioning system shall be considered a part of the overall "Scope".

H. The Contractor shall rough-in fixtures and equipment furnished by others from rough-in and placement drawings furnished by others. The Contractor shall make final connection to fixtures and equipment furnished by others.

I. The Contractor shall participate in the commissioning process as required; including, but not limited to, meeting attendance, completion of checklists, and participation in functional testing.

1.3 SCHEMATIC NATURE OF CONTRACT DOCUMENTS

A. The Contract Documents are schematic in nature in that they are only to establish scope and a minimum level of quality. They are not to be used as actual working construction drawings. The actual working construction drawings shall be the reviewed shop drawings.

B. All duct or pipe or equipment locations as indicated on the documents do not indicate every transition, offset, or exact location. All transitions, offsets, clearances and exact locations shall be established by actual field measurements, coordination with the structural, architectural and reflected ceiling plans, and other trades. Submit shop drawings for review.

C. All transitions, offsets and relocations as required by actual field conditions shall be performed by the Contractor at no additional cost to the Owner.

D. Additional coordination with electrical contractor may be required to allow adequate clearances of electrical equipment, fixtures and associated appurtenances. Contractor to notify Architect and Engineer of unresolved clearances, conflicts or equipment locations.

1.4 SITE VISIT AND FAMILIARIZATION

A. Before submitting a bid, it will be necessary for each Contractor whose work is involved to visit the site and ascertain for himself the conditions to be met therein in installing his work and make due provision for same in his bid. It will be assumed that this Contractor in submitting his bid has visited the premises and that his bid covers all work necessary to properly install the equipment shown. Failure on the part of the Contractor to comply with this requirement shall not be considered justification for the omission or faulty installation of any work covered by these Specifications and Drawings.

B. Understand the existing utilities from which services will be supplied; verify locations of utility services, and determine requirements for connections.

C. Determine in advance that equipment and materials proposed for installation fit into the confines indicated.

1.5 WORK SPECIFIED IN OTHER SECTIONS

A. Finish painting is specified. Prime and protective painting are included in the work of this Division.

B. Owner and General Contractor furnished equipment shall be properly connected to Mechanical (HVAC) systems.

C. Furnishing and installing all required Mechanical (HVAC) equipment control relays and electrical interlock devices, conduit, wire and J-boxes are included in the Work of this Division.

1.6 PERMITS, TESTS, INSPECTIONS

A. Arrange and pay for all permits, fees, tests, and all inspections as required by governmental authorities.

1.7 DATE OF SUBSTANTIAL COMPLETION

A. The date of final acceptance shall be the date of substantial completion. Refer to Division One for additional requirements.

B. The date of final acceptance shall be documented in writing and signed by the Architect, Owner and Contractor.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Deliver products to the project at such time as the project is ready to receive the equipment, pipe or duct - properly protected from incidental damage and weather damage.

C. Damaged equipment, duct or pipe shall be promptly removed from the site and new, undamaged equipment, pipe or duct shall be installed in its place promptly with no additional charge to the Owner.

1.9 NOISE AND VIBRATION

A. The heating, ventilating and air conditioning systems, and the component parts thereof, shall be guaranteed to operate without objectionable noise and vibration.

B. Provide foundations, supports and isolators as specified or indicated, properly adjusted to prevent transmission of vibration to the building structure, piping and other items.

C. Carefully fabricate ductwork and fittings with smooth interior finish to prevent turbulence and generation or regeneration of noise.

D. All equipment shall be selected to operate with minimum of noise and vibration. If, in the opinion of the Architect, objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of the Work, the Contractor shall rectify such conditions without extra cost to the Owner.

1.10 DELEGATED DESIGN FOR ANCHORAGE OF ROOF MOUNTED EQUIPMENT

A. The Contractor shall engage a qualified professional engineer to design all roof mounted equipment curbs, equipment supports, equipment tie downs, equipment connections, and methods of attachment for components that are to be anchored to the building structure. The design shall comply with wind load and uplift requirements utilizing design criteria per ICC (IBC) and ASCE 7 unless criteria is otherwise indicated in the Construction Documents.

B. Submittal: Signed and sealed engineering analysis data and accompanying details, drawings, and supplemental installation information shall be submitted to the engineer for review.

1.11 APPLICABLE CODES AND STANDARDS

A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.

B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.

C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements which includes and is not limited to the following nationally accepted codes and standards:

1. Air Moving & Conditioning Association, AMCA.

2. American Standards Association, ASA.

3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.

4. American Society of Mechanical Engineers, ASME.

5. American Society of Plumbing Engineers, ASPE.

6. American Society of Testing Materials, ASTM.

7. American Water Works Association, AWWA.

8. National Bureau of Standards, NBS.

9. National Fire Protection Association, NFPA.

10. Sheet Metal & Air Conditioning Contractors' National Association, SMACNA.

11. Underwriters' Laboratories, Inc., UL.

12. International Building Code, IBC.

13. International Energy Conservation Code, IECC.

14. International Fire Code, IFC.

15. International Fuel Gas Code, IFGC.

16. International Mechanical Code, IMC.

D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.

E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

1.12 DEFINITIONS AND SYMBOLS

A. General Explanation: A substantial amount of construction and Specification language constitutes definitions for terms found in other Contract Documents, including Drawings which must be recognized as diagrammatic and schematic in nature and not completely descriptive of requirements indicated thereon. Certain terms used in Contract Documents are defined generally in this article, unless defined otherwise in Division 01.

B. Definitions and explanations of this Section are not necessarily either complete or exclusive, but are general for work to the extent not stated more explicitly in another provision of the Contract Documents.

C. Indicated: The term "Indicated" is a cross-reference to details, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications and to similar means of recording requirements in Contract Documents. Where such terms as "Shown", "Noted", "Scheduled", "Specified" and "Detailed" are used in lieu of "Indicated", it is for the purpose of helping the reader locate cross-reference material, and no limitation of location is intended except as specifically shown.

D. Directed: Where not otherwise explained, terms such as "Directed", "Requested", "Accepted", and "Permitted" mean by the Architect or Engineer. However, no such implied meaning will be interpreted to extend the Architect's or Engineer's responsibility into the Contractor's area of construction supervision.

E. Reviewed: Where used in conjunction with the Engineer's response to submittals, requests for information, applications, inquiries, reports and claims by the Contractor the meaning of the term "Reviewed" will be held to limitations of Architect's and Engineer's responsibilities and duties as specified in the General and Supplemental Conditions. In no case will "Reviewed" by Engineer be interpreted as a release of the Contractor from responsibility to fulfill the terms and requirements of the Contract Documents.

F. Furnish: Except as otherwise defined in greater detail, the term "Furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

G. Install: Except as otherwise defined in greater detail, the term "Install" is used to describe operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance.

H. Provide: Except as otherwise defined in greater detail, the term "Provide" is used to mean "Furnish and Install", complete and ready for intended use, as applicable in each instance.

I. Installer: Entity (person or firm) engaged by the Contractor, or its Subcontractor or Sub-subcontractor for performance of a particular unit of work at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance. It is a general requirement that such entities (Installers) be expert in the operations they are engaged to perform.

J. Imperative Language: Used generally in Specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by the Contractor. For clarity of reading at certain locations, contrasting subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor or, when so noted, by other identified installers or entities.

K. Minimum Quality/Quantity: In every instance, the quality level or quantity shown or specified is intended as minimum quality level or quantity of work to be performed or provided. Except as otherwise specifically indicated, the actual work may either comply exactly with that minimum (within specified tolerances), or may exceed that minimum within reasonable tolerance limits. In complying with requirements, indicated or scheduled numeric values are either minimums or maximums as noted or as appropriate for the context of the requirements. Refer instances of uncertainty to Owner or Engineer via a request for information (RFI) for decision before proceeding.

L. Abbreviations and Symbols: The language of Specifications and other Contract Documents including Drawings is of an abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual word abbreviations of a self-explanatory nature have been included in text of Specifications and Drawings. Specific abbreviations and symbols have been established, principally for lengthy technical terminology and primarily in conjunction with coordination of Specification requirements with notations on Drawings and in Schedules. These are frequently defined in Section at first instance of use or on a Legend and Symbol Drawing. Trade and industry association names and titles of generally recognized industry standards are frequently abbreviated. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of Contract Documents so indicate. Except as otherwise indicated, graphic symbols and abbreviations used on Drawings and in Specifications are those recognized in construction industry for indicated purposes. Where not otherwise noted symbols and abbreviations are defined by the latest ASHRAE Fundamentals Handbook, Chapter 39 "Abbreviations and Symbols", ASME and ASPE published standards.

1.13 DRAWINGS AND SPECIFICATIONS

A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the Work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.

B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In the event of discrepancy between Drawings and Specifications, or within either Drawings or Specifications, the greater or more costly of the discrepancy shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least seven (7) working days prior to bid opening date for issuance of an addendum.

C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is the equivalent of the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturer’s standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.

D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.

E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equivalent capacity, construction, and performance. However, under no circumstances shall any substitution be made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 calendar days prior to the bid date without fail.

F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.

G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equivalent construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.

H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUIVALENT" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUIVALENT" product, material or method may be used if it complies with the Specifications and is submitted for review to the Engineer as outline herein.

I. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) Design Documents and all other trades, including Division 26.

J. Changes in architectural, structural, electrical, mechanical, and plumbing requirements for the substitution shall be the responsibility of the bidder wishing to make the substitution. This shall include the cost of redesign by the affected designer(s). Any additional cost incurred by affected Subcontractors shall be the responsibility of this bidder and not the Owner.

K. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.

L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with the requirements listed above; and if accepted, will issue a letter allowing the substitutions.

M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with their respective trade(s) and all other trades; and to pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

1.14 SUBMITTALS

A. Coordinate with Division 01 for submittal timetable requirements, unless noted otherwise within thirty (30) days after the Contract is awarded. The Contractor shall submit an electronic copy of a complete set of shop drawings and complete data covering each item of equipment or material. The submittal of each item requiring a submittal must be received by the Architect or Engineer within the above thirty-day period. The Architect or Engineer shall not be responsible for any delays or costs incurred due to excessive shop drawing review time for submittals received after the thirty (30) day time limit. The Architect and Engineer will retain a copy of all shop drawings for their files. All literature pertaining to items subject to Shop Drawing submittal shall be submitted at one time. Submittals shall be placed in one electronic file in PDF format and bookmarked for individual specification sections. Individual electronic files of submittals for individual specifications shall not be permitted. Each submittal shall include the following items:

1. A cover sheet with the names and addresses of the Project, Architect, MEP Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the section number covering the item or items submitted and the item nomenclature or description.

2. An index page with a listing of all data included in the Submittal.

3. A list of variations page with a listing of all variations, including unfurnished or additional required accessories, items or other features, between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "NO VARIATIONS". Where variations affect the work of other Contractors, then the Contractor shall certify on this page that these variations have been fully coordinated with the affected Contractors and that all expenses associated with the variations will be paid by the submitting Contractor. This page will be signed by the submitting Contractor.

4. Equipment information including manufacturer's name and designation, size, performance and capacity data as applicable. All applicable Listings, Labels, Approvals and Standards shall be clearly indicated.

5. Dimensional data and scaled drawings as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances clearly indicated and labeled at a minimum scale of 1/4" = 1'-0", as required to demonstrate that the alternate or substituted product will fit in the space available.

6. Identification of each item of material or equipment matching that indicated on the Drawings.

7. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements or accessories shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method.

8. Additional information as required in other Sections of this Division.

9. Certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Drawings and Specifications, signed and dated in long hand. Submittals that do not comply with the above requirements shall be returned to the Contractor and shall be marked "REVISE AND RESUBMIT".

B. Refer to Division 00 and Division 01 for additional information on shop drawings and submittals.

C. Equipment and materials submittals and shop drawings will be reviewed for compliance with design concept only. It will be assumed that the submitting Contractor has verified that all items submitted can be installed in the space allotted. Review of shop drawings and submittals shall not be considered as a verification or guarantee of measurements or building conditions.

D. Where shop drawings and submittals are marked "REVIEWED", the review of the submittal does not indicate that submittals have been checked in detail nor does it in any way relieve the Contractor from his responsibility to furnish material and perform work as required by the Contract Documents.

E. Shop drawings shall be reviewed and returned to the Contractor with one of the following categories indicated:

1. REVIEWED: Contractor need take no further submittal action, shall include this submittal in the O&M manual and may order the equipment submitted on.

2. REVIEWED AS NOTED: Contractor shall submit a letter verifying that required exceptions to the submittal have been received and complied with including additional accessories or coordination action as noted, and shall include this submittal and compliance letter in the O&M manual. The contractor may order the equipment submitted on at the time of the returned submittal providing the Contractor complies with the exceptions noted.

3. NOT APPROVED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is not approved. The Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or Drawings. Contractor shall not order equipment that is not approved. Repetitive requests for substitutions will not be considered.

4. REVISE AND RESUBMIT: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked revise and resubmit. The Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or provide as noted on previous shop drawings. Contractor shall not order equipment marked revise and resubmit. Repetitive requests for substitutions will not be considered.

5. CONTRACTOR'S CERTIFICATION REQUIRED: Contractor shall resubmit submittal on material, equipment or method of installation. The Contractor's stamp is required stating that the submittal meets all conditions of the Contract Documents. The stamp shall be signed by the General Contractor. The submittal will not be reviewed if the stamp is not placed and signed on all shop drawings.

6. MANUFACTURER NOT AS SPECIFIED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked manufacturer not as specified. The Contractor will automatically be required to furnish the product, material or method named in the Specifications. Contractor shall not order equipment when submittal is marked manufacturer not as specified. Repetitive requests for substitutions will not be considered.

F. Materials and equipment which are purchased or installed without submittal review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Owner or Engineer for any reason shall be at the expense of the Contractor. The responsible Contractor shall remove the material and equipment noted above and replace with specified equipment or material at his own expense when directed in writing by the Architect or Engineer.

G. Shop Drawing Submittals shall be complete and checked prior to submission to the Engineer for review.

H. Submittals are required for, but not limited to, the following items subject to project requirements:

1. Coordination Drawings
2. Common Motor Requirements for HVAC Equipment
3. Expansion Fittings and Loops for HVAC Piping
4. Variable Frequency Motor Speed Control for HVAC Equipment
5. Hangers and Support for Piping and Equipment HVAC
6. Vibration and Seismic Controls for HVAC Piping and Equipment
7. Testing, Adjusting, and Balancing
8. Duct Insulation
9. HVAC Equipment Insulation
10. HVAC Piping Insulation
11. Refrigerant Monitor System
12. Energy Management and Control System
13. Above Ground Hydronic Piping
14. Refrigerant Piping

15. Metal Ductwork

16. Ductwork Accessories

17. HVAC Fans

18. High-Volume Low-Speed Propeller Fans

19. Series Fan Powered Terminal Units

20. Air Distribution Devices

21. Air Filters

22. Modular Indoor Central Station Air Handling Units

23. Packaged Air Handling Unit

24. Modular Outdoor Central Station Air Handling Units

25. Rooftop Heating and Cooling Units Electric Cooling-Electric Heat

26. Variable Air Volume Rooftop Units

I. Refer to other Division 23 sections for additional submittal requirements. Provide samples of actual materials and/or equipment to be used on the Project upon request of the Owner or Engineer.

1.15 COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of pipe, duct, equipment, and other materials. Include the following:

a. Wall and type locations.

b. Clearances for installing and maintaining insulation.

c. Locations of light fixtures and sprinkler heads.

d. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.

e. Equipment connections and support details.

f. Exterior wall and foundation penetrations.

g. Routing of storm and sanitary sewer piping.

h. Fire-rated wall and floor penetrations.

i. Sizes and location of required concrete pads and bases.

j. Valve stem movement.

k. Structural floor, wall and roof opening sizes and details.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

4. Prepare reflected ceiling plans to coordinate and integrate installations, air distribution devices, light fixtures, communication systems components, and other ceiling-mounted items.

B. This Contractor shall be responsible for coordination of all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.

C. By submitting coordination drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

1.16 RECORD DOCUMENTS

A. Prepare Record Documents in accordance with the requirements of Division 00 and Division 01, in addition to the requirements specified in Division 23.

B. The Contractor shall maintain a separate set of clearly and legibly marked Record Drawings on the job site to record all changes and modifications, including, but not limited to the following: work details, alterations to meet site conditions, and changes made by "Change Order" notices. Mark the drawings with colored pencil(s). These shall be available for review by the Owner, Architect or Engineer during the entire construction stage.

C. The Record Drawings shall be updated concurrently as construction progresses, and in no case less frequently than a daily basis. They shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents. All dimensions shall include at least two dimensions to permanent structure points.

D. Record Drawings shall indicate, at a minimum, the following installed conditions:

1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.

2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.

3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

5. Contract Modifications, actual equipment and materials installed.

E. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified herein to record the locations and invert elevations of underground installations.

F. If the Contractor does not keep an accurate set of Record Drawings, the pay request may be altered or delayed at the request of the Architect. Delivery of Record Documents is a condition of final acceptance. Record Drawings shall be furnished in addition to Shop Drawings.

G. The Contractor shall submit an electronic copy of the record documents in PDF format and one (1) full size set of Record Drawing prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The drawings shall have the name(s) and seal(s) of the Engineer(s) removed or blanked out and shall be clearly marked and signed on each sheet as follows:

CERTIFIED RECORD DRAWINGS

DATE:

(NAME OF GENERAL CONTRACTOR)

BY: _____

(SIGNATURE)

(NAME OF SUBCONTRACTOR)

BY: _____

(SIGNATURE)

1.17 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with Division 00 and Division 01 and, in addition to the requirements specified in those Divisions, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

a. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

b. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

c. Servicing instructions and lubrication charts and schedules.

1.18 CERTIFICATIONS AND TEST REPORTS

A. Submit a detailed schedule for completion and testing of each system indicating scheduled dates for completion of system installation and outlining tests to be performed and scheduled date for each test. This detailed completion and test schedule shall be submitted at least 90 days before the projected substantial completion date.

B. Test result reporting forms shall be submitted for review no later than the date of the detailed schedule.

C. Submit 4 copies of all certifications and test reports to the Architect or Engineer for review adequately in advance of substantial completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

D. Certifications and test reports to be submitted shall include, but not be limited to, those items outlined in Section 23 02 00.

1.19 OPERATING AND MAINTENANCE MANUALS

A. Prepare Operations and Maintenance manuals in accordance with the requirements of Division 01 and Division 23. In addition to the requirements of other Sections, this shall include the following information for equipment items:

1. Identifying names, name tags designations and locations for all equipment.

2. Valve tag lists with valve number, type, color coding, location and function.

3. Reviewed Shop Drawing submittals with exceptions noted compliance letter.

4. Fabrication drawings.

5. Equipment and device bulletins and data sheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable, i.e., description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and model numbers of replacement parts.

6. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

7. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

8. Servicing instructions and lubrication charts and schedules.

9. Equipment and motor name plate data.

10. Wiring diagrams.

11. Exploded parts views and parts lists for all equipment and devices.

12. Color coding charts for all painted equipment and conduit.

13. Location and listing of all spare parts and special keys and tools furnished to the Owner.

14. Furnish recommended lubrication schedule for all required lubrication points with listing of type and approximate amount of lubricant required.

B. Coordinate with Division 01 for Operations and Maintenance manual requirements. Unless noted otherwise, bind together in “D ring” style three-ring binders (National model no. 79-883 or equivalent). Binders shall be large enough to allow ¼” of spare capacity. Include three (3) sets with all approved Shop Drawing submittals, fabrication drawings, bulletins, maintenance instructions, operating instructions and parts exploded views and lists for each and every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections with tabbed insertable dividers, labeled for easy reference. Utilize the individual specification section numbers shown in the Mechanical Specifications as an organization guideline. Bulletins containing information about equipment that is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 23 shall be clearly and legibly set forth in memoranda that shall, likewise, be bound with bulletins.

C. In addition to the bound “hard-copy” Operation and Maintenance manuals referenced above, provide an identical electronic copy in searchable PDF format, with all sections bookmarked within the file for easy reference. Provide a USB flash drive with the final manual to the Owner.

D. Operating and Maintenance Manuals shall be turned over to the Owner or Engineer for review a minimum of fourteen (14) working days prior to the beginning of the operator training period.

E. Operating and Maintenance Manuals which the Engineer deems incomplete, poorly organized, or otherwise unacceptable will be rejected in writing. The Contractor will subsequently be required to again turn over Operating and Maintenance Manuals, with all deficiencies corrected, until deemed acceptable by the Engineer.

1.20 OPERATOR TRAINING

A. The Contractor shall furnish the services of factory trained specialists to instruct the Owner's operating personnel. The Owner's operator training shall include a minimum of 12 hours of onsite training in three (3) shifts of four (4) hours each.

B. Before proceeding with the instruction of Owner Personnel, prepare a typed outline in triplicate, listing the subjects that will be covered in this instruction, and submit the outline for review by the Owner. At the conclusion of the instruction period, obtain the signature of each person being instructed on each copy of the reviewed outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.

C. Refer to other Division 23 Sections for additional Operator Training requirements.

1.21 FINAL COMPLETION

A. At the completion of the Work, all equipment and systems shall be tested and faulty equipment and material shall be repaired or replaced. Refer to Sections of Division 23 for additional requirements.

B. Clean and adjust all air distribution devices and replace all air filters immediately prior to Substantial Completion.

C. Touch up and/or refinish all scratched equipment and devices immediately prior to Substantial Completion.

1.22 CONTRACTOR'S GUARANTEE

A. Use of the HVAC systems to provide temporary service during construction period will not be allowed without permission from the Owner in writing; and, if granted, shall not cause the warranty period to start, except as defined below.

B. Contractor shall guarantee to keep the entire installation in repair and perfect working order for a period of one year after the date of the Substantial Completion, and shall furnish (free of additional cost to the Owner) all materials and labor necessary to comply with the above guarantee throughout the year beginning from the date of Substantial Completion, Beneficial Occupancy by the Owner, or the Certificate of Final Payment as agreed upon by all parties.

C. This guarantee shall not include cleaning or changing filters except as required by testing, adjusting and balancing.

D. All air conditioning compressors shall have parts and labor guarantees provided by the equipment manufacturer for a period of not less than 5 years beyond the date of Substantial Completion.

E. Refer to Sections in Division 23 for additional guarantee or warranty requirements.

1.23 TRANSFER OF ELECTRONIC FILES

A. Project documents are not intended or represented to be suitable for reuse by Architect/Owner or others on extensions of this project or on any other project. Any such reuse or modification without written verification or adaptation by Engineer, as appropriate for the specific purpose intended, will be at Architect/Owner's risk and without liability or legal exposure to Engineer or its consultants from all claims, damages, losses and expense, including attorney's fees arising out of or resulting thereof.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently, or otherwise, without authorization of the data's creator, the party receiving the electronic files agrees that it will perform acceptance tests or procedures within sixty (60) days of receipt, after which time the receiving party shall be deemed to have accepted the data thus transferred to be acceptable. Any errors detected within the sixty (60) day acceptance period will be corrected by the party delivering the electronic files. Engineer is not responsible for maintaining documents stored in electronic media format after acceptance by the Architect/Owner.

C. When transferring documents in electronic media format, Engineer makes no representations as to the long term compatibility, usability or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by Engineer at the beginning of the Project.

D. Any reuse or modifications will be at the Contractor's sole risk and without liability or legal exposure to Architect, Engineer or any consultant.

E. The Texas Board of Architectural Examiners (TBAE) has stated that it is in violation of Texas law for persons other than the Architect of record to revise the Architectural drawings without the Architect's written consent.

1. It is agreed that "MEP" hard copy or computer-generated documents will not be issued to any other party except directly to the Architect/Owner. The Contract Documents are contractually copyrighted and cannot be used for any other project or purpose except as specifically indicated in AIA B-141 Standard Form of Agreement Between Architect and Owner.

2. If the client, Architect or Owner of the project requires electronic media for "record purposes", then AutoCAD/ Revit documents will be prepared by Engineer on electronic media such as removable memory devices, flash drives or CD's. These documents can also be submitted via file transfer protocols. AutoCAD/ Revit files will be submitted with all title block references intact to permit the end user to only view and plot the drawings. Revisions will not be permitted in this configuration.

3. At the Architect/Owner's request, Engineer will assist the Contractor in the preparation of the submittals and prepare one copy of AutoCAD/ Revit files on electronic media or submit through file transfer protocols. The electronic media will be prepared with all indicia of documents ownership removed. The electronic media will be prepared in a ".rvt" or ".dwg" format to permit the end user to revise the drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials and equipment manufactured by a domestic United States manufacturer and assembled in the United States for all local and Federal Government projects. These materials and equipment shall comply with "Buy American Act."

B. Access Doors: Provide access doors as required for access to equipment, valves, controls, cleanouts and other apparatus where concealed. Access doors shall have concealed hinges and screw driver cam locks.

C. All access doors located in wet areas such as restrooms, locker rooms, shower rooms, kitchen and any other wet areas shall be constructed of stainless steel.

D. Access Doors: shall be as follows:

1. Plaster Surfaces: Milcor Style K.

2. Ceramic Tile Surface: Milcor Style M.

3. Drywall Surfaces: Milcor Style DW.

4. Install doors only in locations approved by the Architect.

2.2 EQUIPMENT PADS

A. Provide 6-inch-high concrete pads for indoor floor mounted equipment. Pads shall conform to the shape of the equipment with a minimum extension of 6 inch beyond the equipment on all sides. Top and sides of pads shall be troweled to a smooth finish, equivalent to the floor. External corners shall be bullnosed to a 3/4" radius, unless shown otherwise.

B. Provide 6-inch-high concrete pads for all exterior mounted equipment. Pads shall conform to the shape of the equipment with a minimum extension of 6 inch beyond the equipment on all sides. Provide a 4-foot monolithic extension to the pad in front of the equipment for service when mounted on a non-finished area (i.e. landscape, gravel, clay, etc.) Top and sides of pads shall be troweled to a smooth finish. External corners shall be bullnosed to a 3/4" radius, unless shown otherwise.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected via reviewed submittals.

B. Refer to equipment specifications in Divisions 2 through 48 for additional rough-in requirements.

3.2 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment to conform with architectural action markings on submittal, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, resolve conflicts and submit proposed solution to the Architect for review.

9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as possible, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location and label.

11. Install access doors where units are concealed behind finished surfaces. Refer to paragraph 2.1 in this section and architect for access doors specifications and location.

12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

13. Provide roof curbs for all roof mounted equipment. Coordinate with roof construction for pitched roof. Provide roof curbs which match the roof slope and provides a level top for equipment installation. Refer to Architectural drawings and details.

14. The equipment to be furnished under these Specifications shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the product of the same manufacturer.

15. The Architectural and Structural features of the building and the space limitations shall be considered in selection of all equipment. No equipment shall be furnished which will not suit the arrangement and space limitations indicated.

16. Lubrication: Prior to start-up, check and properly lubricate all bearings as recommended by the manufacturer.

17. Where the word "Concealed" is used in these Specifications in connection with insulating, painting, piping, ducts, etc., it shall be understood to mean hidden from sight as in chases, furred spaces or suspended ceilings. "Exposed" shall be understood to mean the opposite of concealed.

18. Identification of Mechanical Equipment:

    a. Mechanical equipment shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic or etched metal. Submittals shall include dimensions and lettering format for approval. Attachment shall be with escutcheon pins, self-tapping screws, or machine screws.

    b. Tags shall be attached to all valves, including control valves, with nonferrous chain. Tags shall be brass and at least 1-1/2 inches in diameter. Nameplate and tag symbols shall correspond to the identification symbols on the temperature control submittal and the "as-built" drawings.

19. Provide construction filters for all air handling units, fan coil unit, VAV boxes, and all other air handling equipment during the entire construction period.

20. Provide temporary construction strains for all strainers in the hydronic systems during the initial flushing of the systems.

3.3 CUTTING AND PATCHING

A. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.

2. Remove and replace defective Work.

3. Remove and replace Work not conforming to requirements of the Contract Documents.

4. Remove samples of installed Work as specified for testing.

5. Install equipment and materials in existing structures.

6. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer/Owner's observation of concealed Work, without additional cost to the Owner.

7. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers; refer to the materials and methods required for the surface and building components being patched; Refer to Paragraph 1.11 I for definition of "Installer."

C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, mechanical ducts and HVAC units, and other mechanical items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.4 WORK SEQUENCE, TIMING, COORDINATION WITH OWNER, ARCHITECT AND ENGINEER

A. The Owner will cooperate with the Contractor, however, the following provisions must be observed:

1. A meeting will be held at the project site, prior to any construction, between the Owner's Representative, the General Contractor, the Sub-Contractors and the Engineer to discuss Contractor's employee parking space, access, storage of equipment or materials, and use of the Owner's facilities or utilities. The Owner's decisions regarding such matters shall be final.

2. During the construction of this project, normal facility activities will continue in existing buildings until renovated areas are completed. Plumbing, fire protection, lighting, electrical, communications, heating, air conditioning, and ventilation systems shall be maintained in service within the occupied spaces of the existing building.

3. Contractor shall not start-up any of the HVAC equipment unless the Owner, Architect and Engineer are signed off.

4. Start-up for major HVAC equipment such as chillers, cooling towers, variable frequency drives and hot water boilers shall be performed by a factory technician. The start-up shall include a written report signed off by Contractor, Engineer and Owner.

3.5 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS

A. In the preparation of these documents every effort has been made to show the approximate locations of, and connections to, the existing piping, duct, equipment and other apparatus related to this phase of the Work. However, this Contractor shall be responsible for verifying all of the above information. This Contractor shall visit the existing site to inspect the facilities and related areas. This Contractor shall inspect and verify all details and requirements of all the Contract Documents, prior to the submission of a proposal. All discrepancies between the Contract Documents and actual job-site conditions shall be resolved by the contractor, who shall produce drawings that shall be submitted to the Architect/Engineer for review. All labor and materials required to perform the work described shall be a part of this Contract.

B. All equipment and/or systems noted on the Drawings "To Remain" shall be inspected and tested on site to certify its working condition. A written report on the condition of all equipment to remain, including a copy of the test results and recommended remedial actions and costs shall be made by this Contractor to the Architect/Engineer for review.

C. All equipment and/or systems noted on the Drawings "To Be Removed" shall be removed including, associated pipe and duct, pipe and duct hangers and/or line supports. Where duct or pipe is to be capped for future or end of line use, it shall be properly tagged with its function or service appropriately identified. Where existing equipment is to be removed or relocated and has an electric motor or connection, the Electrical Contractor shall disconnect motor or connection, remove wiring to a safe point and this Contractor shall remove or relocate motor or connection along with the equipment.

D. During construction and remodeling, portions of the Project shall remain in service. Construction equipment, material, tools, extension cords, etc., shall be arranged so as to present minimum hazard or interruption to the occupants of the building. None of the construction work shall interfere with the proper operation of the existing facility; or be so conducted as to cause harm or danger to persons on the premises. All fire exits, stairs or corridors required for proper access, circulation or exit shall remain clear of equipment, materials or debris. The General Contractor shall maintain barricades, other separations in corridors and other spaces where work is conducted.

E. Certain work during the demolition and construction phases may require overtime or night time shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner at least seventy-two (72) hours in advance in writing.

F. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.

G. Equipment, piping or other potential hazards to the occupants of the building shall not be left overnight outside of the designated working or construction area.

H. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch or replace as required any damage that occurs as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction and to keep construction disrupted areas to a minimum. Coordinate with the Owner and other trades in scheduling and performance of the work.

I. Include in the contract price all rerouting of existing pipe, duct, etc., and the reconnecting of the existing equipment as necessitated by field conditions to allow the installation of the new systems regardless of whether or not such rerouting, reconnecting or relocating is shown on the Drawings. Furnish all temporary pipe, duct, controls, etc., as required to maintain heating, cooling, and ventilation services for the existing areas with a minimum of interruption.

J. All existing pipe, duct, materials, equipment, controls and appurtenances not included in the remodel or alteration areas are to remain in place.

K. Pipe, duct, equipment and controls serving mechanical and other Owner's equipment, etc., which is to remain but is served by pipe, duct, equipment and controls that are disturbed by the remodeling work, shall be reconnected in such a manner as to leave this equipment in proper operating condition.

L. No portion of the fire protection systems shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owner’s representative in order to protect systems that shall remain in service.

M. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and operating system in cooperation with other trades with a minimum of disruption or downtime.

N. Refer to Architectural Demolition and/or Alteration plans for actual location of walls, ceilings, etc., being removed and/or remodeled.

END OF SECTION

SECTION 23 02 01 - COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions 013100 and Supplementary Conditions apply to all Work herein.

1.2 COORDINATION DRAWINGS

A. The Contractor shall take the lead in coordinating the Mechanical, Electrical, Plumbing, Communications, Electronic Safety/Security and Fire Protection systems within the building.

B. The Contractor shall coordinate a three-dimensional (3D) model of the building which includes the Mechanical, Electrical, Plumbing, and Fire Protection systems. The Contractor will be provided with the REVIT model that was used to generate the contract documents, this file may be used as the background file. The Contractor shall replace the systems drawn with the actual shop drawing models. The Contractor is not limited to using REVIT and may use any 3D software in generating and combining the coordination model.

C. Submitting the contract drawings as coordination drawings will not be acceptable.

D. The model shall include detailed and accurate representations of all equipment to be installed based upon the reviewed equipment submittals.

E. The Contractor shall hold a 3-D coordination meeting with all sub-contractors present to review the model and discuss coordination of the installation of the building systems.

F. Upon completion of the coordination meeting, the Contractor shall submit the 3-D model and 1/4” scale drawings for review.

G. The model shall detail major elements, components, and systems in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

H. Indicate the proposed locations of pipe, duct, equipment, and other materials. Include the following:

1. Wall and type locations.

2. Clearances for installing and maintaining insulation.

3. Locations of light fixtures and sprinkler heads.

4. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.

5. Equipment connections and support details.

6. Exterior wall and foundation penetrations.

7. Routing of storm and sanitary sewer piping.

8. Fire-rated wall and floor penetrations.

9. Sizes and location of required concrete pads and bases.

10. Valve stem movement.

11. Structural floor, wall and roof opening sizes and details.

I. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

J. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

K. Prepare reflected ceiling plans to coordinate and integrate installations, air distribution devices, light fixtures, communication systems components, and other ceiling-mounted items.

L. Sequence of Coordination - Below is hierarchy of model elements and the sequencing by which the models will be coordinated.

1. Structural and Architectural model

2. Miscellaneous steel

3. Perform preliminary space allocation

4. Identify hard constraints (locations of access panels, lights, A/V space requirements, etc.)

5. Main and medium pressure ducts from the shaft out

6. Main graded plumbing lines and vents

7. Sprinkler mains and branches

8. Cold and hot water mains and branches

9. Lighting fixtures and plumbing fixtures

10. Smaller sized ducts and flex ducts

11. Smaller size cold water and hot water piping, flex ducts, etc.

M. The Contractor shall not install any item until the coordination has been completed and reviewed by the Construction Manager, Owner, and A/E team.

N. The Contractor shall be responsible for coordination of all items that will affect the installation of the work. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.

O. By submitting shop drawings on the project, the Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all trades.

END OF SECTION

SECTION 23 03 00 - MECHANICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mechanical demolition.

B. The Drawings do not show all demolition work required. The Contractor shall make himself familiar with the required scope of work to accomplish the work required by these documents. All demolition work implied or required shall be included in the scope of this contract.

C. Utility service outages required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner 2 weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

1.2 RELATED SECTIONS

A. Section 02 40 00 - Demolition and Structure Moving.

1.3 WORK SEQUENCE, TIMING, COORDINATION WITH OWNER

A. The Owner will cooperate with the Contractor; however, the following provisions must be observed:

1. During the construction of this project, normal facility activities will continue in existing buildings until new buildings or renovated areas are completed. Plumbing, fire protection, lighting, electrical, communications, heating, air conditioning, and ventilation systems shall be maintained in service within the occupied spaces of the existing building.

2. A meeting will be held at the project site, prior to any construction, between the Owner's Representative, the General Contractor, the Subcontractors and Sub-subcontractors, and the Engineer to discuss Contractor's employee parking space, access, storage of equipment or materials, and use of the Owner's facilities or utilities. The Owner's decisions regarding such matters shall be final.

1.4 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS

A. In the preparation of these documents every effort has been made to show the approximate locations of, and connections to the existing piping, duct, equipment and other apparatus related to this phase of the Work. However, this Contractor shall be responsible for verifying all of the above information. This Contractor shall visit the existing site to inspect the facilities and related areas. This Contractor shall inspect and verify all details and requirements of all the Contract Documents, prior to the submission of a proposal. All discrepancies between the Contract Documents and actual job-site conditions shall be resolved by the contractor, who shall produce drawings which shall be submitted to the Architect/Engineer for review. All labor and materials required to perform the work described shall be a part of this Contract.

B. All equipment and/or systems noted on the Drawings "To Remain" shall be inspected and tested on site to certify its working condition. A written report on the condition of all equipment to remain, including a copy of the test results and recommended remedial actions and costs shall be made by this Contractor to the Architect/Engineer for review.

C. All equipment and/or systems noted on the Drawings "To Be Removed" should be removed including, associated pipe and duct, pipe and duct hangers and/or line supports. Where duct or pipe is to be capped for future or end of line use, it shall be properly tagged with its function or service appropriately identified. Where existing equipment is to be removed or relocated and has an electric motor or connection, the Electrical Contractor shall disconnect motor or connection, remove wiring to a safe point and this Contractor shall remove or relocate motor or connection along with the equipment.

D. During construction and remodeling, portions of the Project shall remain in service. Construction equipment, material, tools, extension cords, etc., shall be arranged so as to present minimum hazard or interruption to the occupants of the building. None of the construction work shall interfere with the proper operation of the existing facility; or be so conducted as to cause harm or danger to persons on the premises. All fire exits, stairs or corridors required for proper access, circulation or exit shall remain clear of equipment, materials or debris. The General Contractor shall maintain barricades, other separations in corridors and other spaces where work is conducted.

E. Certain work during the demolition and construction phases may require overtime or night time shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner at least seventy-two (72) hours in advance in writing.

F. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.

G. Equipment, piping or other potential hazards to the occupants of the building shall not be left overnight outside of the designated working or construction area.

H. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch or replace as required any damage which occurs as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction and to keep construction disrupted areas to a minimum. Coordinate with the Owner and other trades in scheduling and performance of the work.

I. Include in the contract price all rerouting of existing pipe, duct, etc., and the reconnecting of the existing equipment as necessitated by field conditions to allow the installation of the new systems regardless of whether or not such rerouting, reconnecting or relocating is shown on the drawings. Furnish all temporary pipe, duct, controls, etc., as required to maintain heating, cooling, and ventilation services for the existing areas with a minimum of interruption.

J. All existing pipe, duct, materials, equipment, controls and appurtenances not included in the remodel or alteration areas are to remain in place.

K. Pipe, duct, equipment and controls serving mechanical and other Owner's equipment, etc., which is to remain but which is served by pipe, duct, equipment and controls that are disturbed by the remodeling work, shall be reconnected in such a manner as to leave this equipment in proper operating condition.

L. No portion of the fire protection systems shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owner's representative in order to protect systems that shall remain in service.

M. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and operating system in cooperation with other trades with a minimum of disruption or downtime.

N. Refer to Architectural Demolition and/or Alteration plans for actual location of walls, ceilings, etc., being removed and/or remodeled.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Field verify measurements, and piping arrangements are as shown on Drawings.

B. Verify that abandoned piping and equipment serve only abandoned facilities.

C. Demolition Drawings are based on casual field observation and existing Record Documents. Report discrepancies to Architect and Engineer before disturbing existing installation.

D. Beginning of demolition means that the contractor accepts existing conditions.

3.2 PREPARATION

A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with Utility Company.

C. Provide temporary connections, if required, to maintain existing systems in service during construction. When work must be performed on energized equipment, use personnel experienced in such operations.

D. Existing Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner and local fire service at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing mechanical work under provisions of Division 02 and this Section.

B. Remove, relocate, and extend existing systems to accommodate new construction.

C. Remove abandoned piping to source of supply.

D. Remove exposed abandoned piping systems, including abandoned systems above accessible ceiling finishes. Cut systems flush with walls and floors, and patch surfaces.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to existing systems which remain active. Modify installation or provide access doors as appropriate.

G. Extend existing systems using materials and methods compatible with existing systems, or as specified.

H. All existing equipment that includes a refrigeration circuit that is to be demolished or relocated shall have the refrigerant charge recovered prior to demolition or relocation. Refrigerant recovery shall comply with EPA, state, and local jurisdiction requirements. Recovered refrigerants shall not be used in any system, new or existing, unless the refrigerant has been reclaimed and found to meet the purity requirements of AHRI 700.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 02.

3.6 REMOVAL OF MATERIALS

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials include but are not limited to: condenser parts, fan motors, fan blades, fan brackets, circuit boards, screens, wiring, circuit breakers, contactors, fuses, actuators, transducers, safety device, freon, VFD drives, relays, DDC controllers, sensors, CT's, pressure sensors, flow meters, dampeners, actuators, and isolation actuators shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. The list above is not 100% comprehensive. Some items may not be reclaimed. Items not on the above list may be reclaimed. Any claims made by the District for items not on the above list does not entitle the Contractor to any changes or adjustments to the terms or conditions of this contract. The District will indicate to the Contractor one week prior to the Contractors scheduled (District's published schedule) start of demolition what items the District intends to reclaim, if any. The Contractor is responsible to remove and segregate those items and protect them from harm or unauthorized removal until the District arrives to pick them up the week after demolition completion. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operating condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

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

C. Existing equipment that is to be relocated shall be verified to be in proper operating condition prior to equipment relocation. Verification shall be performed by equipment manufacturer's authorized service representative. If existing equipment is found to be deficient, the service representative shall notify the engineer and Owner and provide recommendations to restore equipment to proper operating condition.

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

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

F. Certain work during the demolition and construction phases may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner's Representative at least 72 hours in advance in writing.

G. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace as required any damage which occurs as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.

H. See Paragraph I on page 23 02 00 – 18

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

J. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

K. Where partitions, walls, floors, or ceilings of existing construction are being removed, all contractors shall remove and reinstall in locations approved by the Architect all devices required for the operation of the various systems installed in the existing construction.

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

B. WORK SPECIFIED ELSEWHERE:

1. Painting
2. Automatic temperature controls
3. Power control wiring to motors and equipment

1.3 WARRANTY

A. Warrant the Work specified herein for one year and motors for five years beginning on the date of substantial completion.

1.4 REFERENCE STANDARDS

A. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.

B. NEMA MG 00001 - Motors and Generators; 2024.

1.5 SUBMITTALS

A. SHOP DRAWINGS: Indicate size material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.

B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures variations, and accessories.

C. MOTOR NAMEPLATE INFORMATION: Manufacturer's name, address, utility and operating data.

D. Refer to Division One for additional information.

1.6 DELIVERY AND STORAGE

A. DELIVERY: Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.

B. TIME AND COORDINATION: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.

C. STORAGE: Store materials in a clean, dry location, protected from weather and abuse.

PART 2 - PRODUCTS

2.1 ELECTRIC MOTORS

A. APPROVED MANUFACTURERS: Provide motors by a single manufacturer as much as possible.

1. Baldor
2. Marathon
3. Siemens-Allis
4. General Electric
5. U.S. Motor

B. TEMPERATURE RATING: Provide insulation as follows:

1. CLASS B: 40 degrees C maximum.
2. CLASS F:
    a. Between 40 degrees C and 65 degrees C maximum.
    b. Totally enclosed motors.

C. STARTING CAPABILITY: As required for service indicated five starts minimum per hour.

D. PHASES AND CURRENT: Verify electrical service compatibility with motors to be used.

1. UP TO 3/4 HP: Provide electronically commutated brushless DC single phase motors with built-in inverter and microprocessor-based control.
2. 1 HP AND LARGER: Provide squirrel-cage AC induction polyphase motors.
3. Name plate voltage shall be the same as the circuit's nominal voltage, serving the motor.

E. SERVICE FACTOR: 1.15 for polyphase; 1.35 for single phase.

F. FRAMES: U-frames 1.5 hp. and larger.

G. BEARINGS: Provide sealed re-greaseable ball bearings; with top mounted Zerk lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:

1. Design for thrust where applicable.

2. PERMANENTLY SEALED: Where not accessible for greasing.

3. SLEEVE-TYPE WITH OIL CUPS: Light duty fractional hp. motors or polyphase requiring minimum noise level.

H. ENCLOSURE TYPE: Provide enclosures as follows, except where otherwise indicated:

1. CONCEALED INDOOR: ODP (Open Drip Proof).

2. EXPOSED INDOOR: Guard Protected.

3. OUTDOOR TYPICAL: Type II. TEFC.

4. OUTDOOR WEATHER PROTECTED: Type I. WPI.

5. EXPLOSION PROOF, XP: For use in hazardous locations.

I. OVERLOAD PROTECTION: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.

J. NOISE RATING: "Quiet" except where otherwise indicated.

K. All motors that are to be operated by a variable frequency drive shall be inverter duty rated motors.

L. All motors operated by variable frequency drive shall be equipped with a maintenance free, conductive microfiber, shaft grounding ring with a minimum of two rows of circumferential microfibers to discharge electrical shaft currents within the motor and/or its bearings.

M. EFFICIENCY: Minimum full load efficiency listed in the following table, when tested in accordance with IEEE 112, Method B, including stray load loss measure.

NEMA MG 00001 Efficiency - 1800 RPM Synchronous Speed		
Motor horsepower	Index Letter	Minimum Efficiency
3 - 5	G	89.5
7.5	G	91.0
10	F	91.7
15 - 20	E	93.0
25 - 30	E	93.6
40	D	94.1
50	C	95.0
60	C	95.0
75	C	95.0
100 - 125	B	95.4
150 - 200	B	95.8
NEMA MG 00001 Efficiency - 1200 RPM Synchronous Speed		
Motor horsepower	Index Letter	Minimum Efficiency
3 - 5	G	89.5
7.5	G	90.2
10	F	91.7

15	F	91.7
20	E	92.4
25 - 30	E	93.6
40 - 50	D	94.1
60	D	94.5
75	C	94.5
100 - 125	C	95.0
150 - 200	B	95.4

2.2 MOTOR CONTROLLERS (STARTERS)

A. All motor controllers (for equipment furnished under Division 23) shall be furnished under Division 23 and installed under Division 26 unless otherwise noted on the plans.

1. Starters shall be provided for 3 phase motors 1 horsepower and greater.

B. Motor starters shall be furnished as follows.

1. GENERAL: Motor starters shall be Square D Company Class 8536 across-the-line magnetic type, full-voltage, non-reversing (FAVOR) starter. All starters shall be constructed and tested in accordance with the latest NEMA standards, sizes and horsepower. ICE sizes are not acceptable. Starters shall be mounted in a general purpose dead front, painted steel enclosure and surface-mounted. Provide size and number of poles as shown and required by equipment served. Provide two speed, two winding or two speed, single winding motor starter as required for two speed motors.

2. CONTACTS: Magnetic starter contacts shall be double break solid silver alloy. All contacts shall be replaceable without removing power wiring or removing starter from panel. The starter shall have straight-through wiring.

3. OPERATING COILS: Operating coils shall be 120 volts and shall be of molded construction. When the coil fails, the starter shall open and shall not lock in the closed position.

4. OVERLOAD RELAYS: Provide manual reset, trip-free Class 20 overload relays in each phase conductor in of all starters. Overload relays shall be melting alloy type with visual trip indication. All 3 phase and single phase starters shall have one overload relay in each underground conductor. Relay shall not be field adjustable from manual to automatic reset. Provide 6 overload relays for two speed motor starters.

5. PILOT LIGHTS: Provide a red running pilot light for all motor starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter and shall not be wired across the operating coil.

6. CONTROLS: Provide starters with HAND-OFF-AUTOMATIC switches. Coordinate additional motor starter controls with the requirements of Division 23. Motor starter controls shall be mounted in the starter enclosure cover.

7. CONTROL POWER TRANSFORMER: Provide a single-phase 480 volt control power transformer with each starter for 120 volt control power. Connect the primary side to the line side of the motor starter. The primary side shall be protected by a fuse for each conductor. The secondary side shall have one leg fused and one leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.

8. AUXILIARY CONTACTS: Each starter shall have one normally open and one normally closed convertible auxiliary contact in addition to the number of contacts required for the "holding interlock", remote monitoring, and control wiring. In addition, it shall be possible to field-install three more additional auxiliary contacts without removing existing wiring or removing the starter from its enclosure.

9. UNIT WIRING: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for line and load power wiring and HVAC control wiring.

10. ENCLOSURES: All motor starter enclosures shall be NEMA 1, general purpose enclosures or NEMA-3R if mounted exposed to high moisture conditions. Provide NEMA 4X when located by cooling towers.

11. POWER MONITOR: Provide a square "D" 8430 MPS phase failure and under-voltage relay, base and wiring required for starters serving all 3 phase motors. Set the under-voltage setting according to minimum voltage required for the motor to operate within its range.

C. APPROVED MANUFACTURERS: Controller numbers are based on first named manufacturer. Provide one of the following manufacturer's.

1. Siemens

2. Square D

3. ABB

4. Eaton

2.3 COMBINATION MOTOR STARTERS

A. GENERAL: Combination motor starters shall consist of a magnetic starter and a fusible or non-fusible disconnect switch in a dead front, painted steel NEMA 1 enclosure unless otherwise noted and shall be surface-mounted. Size and number of poles shall as shown and required by equipment served. Combination motor starters shall be as specified for motor starters in Paragraph 2.02-B, except as modified herein.

B. DISCONNECT SWITCH: Disconnect switches shall be as specified in Section 26 28 16.

C. APPROVED MANUFACTURERS: Controller numbers are based on first named manufacturer. Provide one of the following manufacturer's.

1. Siemens

2. Square D

3. ABB

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed in accordance with the manufacturers' recommendations and printed installation instructions.

B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Contractors' price shall include all items required as per manufacturers' requirements.

C. Install in a professional manner. Any part or parts not meeting this requirement shall be replaced or rebuilt without extra expense to Owner.

D. Install rotating equipment in static and dynamic balance.

E. Provide foundations, supports, and isolators properly adjusted to allow minimum vibration transmission within the building.

F. Correct objectionable noise or vibration transmission in order to operate equipment satisfactorily as determined by the Engineer.

END OF SECTION

SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 WORK INCLUDED

A. Flexible pipe connections.

B. Expansion joints and compensators

C. Pipe loops, offsets, and swing joints.

1.3 RELATED WORK

A. Section 23 05 29 - Hangers and Supports for Piping and Equipment - HVAC

B. Section 23 21 13 - Above Ground Hydronic Piping

C. Section 23 22 13 - Steam and Condensate Heating Piping

D. Section 23 23 00 - Refrigerant Piping

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.

B. Expansion Calculations:

1. Installation Temperature: 50 degrees F (10 degrees C)

2. Hot Water Heating: 210 degrees F (99 degrees C)

3. Domestic Hot Water: 140 degrees F (60 degrees C)

4. Steam: 380 degrees F (193 degrees C)

5. Steam Condensate: 212 degrees F (100 degrees C)

6. Safety Factor: 30 percent.

C. Pipe sizes indicated are to establish a minimum quality of compensator. Refer to manufacturer’s literature for model series for different pipe sizes.

1.5 SUBMITTALS

A. Submit shop drawings under provisions of Division One.

B. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

C. Design Data: Indicate selection calculations.

D. Manufacturer`s Installation Instructions: Indicate special procedures, and external controls.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division One.

B. Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division One.

B. Maintenance Data: Include adjustment instructions.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

B. Design expansion compensation system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the state where the project is located.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Division One.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

A. Provide five year warranty under provisions of Division One.

B. Warranty: Include coverage for leak free performance of packed expansion joints.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Division One.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Steel Piping (Based on 2" Pipe):

1. Manufacturers:

a. VMC Group, Model SS-PM or SS-FP

b. Mercer Rubber Company, Model BSS-EM (Mason Industries)

2. Inner Hose: Type 321, stainless steel, corrugated metal.

3. Exterior Sleeve: Type 304, single braided stainless steel.

4. Pressure Rating: 350 psig WOG and 70 degrees F. For 4 inch pipe - 200 psig WOG and 70 degrees F.

5. Joint: Schedule 40 steel, threaded with male nipple and hex boss each end and union. Flanged joints for pipe sizes 2½ inch and larger.

6. Size: Use pipe sized units.

7. Maximum offset: 1/2 inch on each side of installed center line.

8. Application: Air handling unit cooling and heating coils.

B. Copper Piping (Based on 2" Pipe):

1. Manufacturers:

a. VMC Group, Model BR-FS

b. Mercer Rubber Company, Model BFF (Mason Industries)

2. Inner Hose: Corrugated Bronze

3. Exterior Sleeve: Braided bronze.

4. Pressure Rating: 250 psig WOG and 70 degrees F.

5. Joint: Threaded with male nipple and hex boss each end with union. Flanged joints for pipe sizes 2½ inch and larger.

6. Size: Use pipe sized units.

7. Maximum offset: 1/2 inch on each side of installed center line.

8. Application: Air handling unit cooling and heating coils.

2.2 EXPANSION JOINTS

A. Bellows Type (Based on 4" Pipe):

1. Manufacturers:

a. VMC Group, Model EB

b. Mercer Rubber Company, Model 803 or 805 (Mason Industries)

2. Body: Monel wire reinforced molded TFE teflon bellows, multiple arch.

3. Pressure Rating: 70 psig WSP and 250 degrees F (66 degrees C).

4. Maximum Compression: 1 inch.

5. Maximum Extension: 1 inch.

6. Maximum Offset: 1/2 inch.

7. Joint: ASA standard ductile iron flanges, integral molded gasket.

8. Size: Use pipe sized units.

9. Accessories: Control rod limit bolts.

10. Application: Steel piping 8 inch and under.

2.3 ACCESSORIES

A. Pipe Alignment Guides to Direct Axial Movement:

1. Manufacturers:

a. Metraflex, Style IV

2. Two piece welded steel with shop paint, and bolted to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer`s instructions.

B. Construct spool pieces to exact size of flexible connection for future insertion.

C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provided line size flexible connectors.

D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

E. Provide miscellaneous metals to rigidly anchor pipe to building structure. Provide pipe guides so that movement takes place along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

3.2 MANUFACTURER`S FIELD SERVICES

A. Prepare and start systems under provisions of Division One.

B. Provide inspection services by flexible pipe manufacturer`s representative for final installing and certify installation is in accordance with manufacturer`s recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT - HVAC

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 WORK INCLUDED

A. Pipe, and equipment hangers, supports and associated anchors.

B. Sleeves and seals.

C. Flashing and sealing equipment and pipe stacks.

1.3 RELATED WORK

A. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

B. Section 23 07 16 - HVAC Equipment Insulation

C. Section 23 07 19 - HVAC Piping Insulation

D. Section 23 21 13 - Above Ground Hydronic Piping

E. Section 23 21 16 - Underground Hydronic Piping

1.4 REFERENCES

A. ASME B31.1 - Power Piping; 2024.

B. ASME B31.9 - Building Services Piping; 2025.

C. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

1.5 QUALITY ASSURANCE

A. Hangers and Supports for HVAC Piping: In conformance with ASME B31.1 and ASME B31.9.

B. Hangers and Supports for HVAC Piping: In conformance with MSS SP-58.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division One.

B. Indicate hanger and support framing and attachment methods.

C. Provide delegated design submittal for equipment anchorage as required in specification 23 02 00 - Part 1.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipes Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.

B. Hangers for Pipes Sizes 2 to 4 Inch: Carbon steel, adjustable clevis.

C. Hangers for Pipes Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roller, double hanger.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers, pre-formed manufactured saddles and hanger rods; cast iron roller and stand for pipe sizes 6 inches and over.

E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

F. Wall Support for Pipe Sizes 4 Inches and over: adjustable steel yoke and cast iron roller.

G. Vertical Support: Steel riser clamp.

H. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

I. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roller and stand, steel screws, and concrete pier or steel support.

J. Roof Pipe Supports and Hangers: Galvanized Steel Channel System as manufactured by Portable Pipe Hangers, Inc. or approved equal.

1. For pipes 2-1/2” and smaller - Type PP10 with roller

2. For pipes 3” through 8” - Type PS

3. For multiple pipes - Type PSE - Custom

K. Copper Pipe Support and Hangers: Electro-galvanized with thermoplastic elastomer cushions; Unistrut “Cush-A-Clamp” or equal. Hangers: Plastic coated; Unistrut or equal.

L. Shields for Vertical Copper Pipe Risers: Sheet lead.

M. Pipe Rough-In Supports in Walls/Chases: Provide preformed plastic pipe supports, Sioux Chief “Pipe Titan” or equal.

2.2 HANGER RODS

A. Galvanized Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS

A. Inserts: Malleable iron case with galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 20 gage galvanized steel.

B. Lead Flashing: 4 lb. /sq. ft. sheet lead for waterproofing; 1 lb. /sq. ft. sheet lead for soundproofing.

C. Caps: Steel, 20 gage minimum; 16 gage at fire resistant elements.

D. Coordinate with roofing contractor/Architect for type of flashing on metal roofs.

2.5 EQUIPMENT CURBS

A. Fabricate curbs of hot dipped galvanized steel.

B. For metal roof construction, roof curbs shall be made of aluminum or stainless steel. Coordinate with Architectural Drawings and details.

2.6 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: Form with 18 gage galvanized steel, tack welded to form a uniform sleeve.

B. Sleeves for Pipes through Beams, Interior Walls, Exterior Walls, Footings, and Potentially Wet Floors: Form with steel pipe, Schedule 40, galvanized.

C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Fireproofing: Prefabricated fire rated steel sleeves including seals, UL listed, manufactured by Hilti.

D. Fire Stopping Insulation: Glass fiber type, non-combustible, UL listed.

E. Caulk: Paintable 25-year acrylic sealant.

F. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted, two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

2.7 MECHANICAL SLEEVE SEALS

A. Modular sealing element unit, designed for field assembly, to continuously fill annular space between pipe and sleeve and create watertight seal.

1. Approved Manufacturers:

a. Link-Seal by Garlock Pipeline Technologies (GPT)

b. Innerlynx by Advance Products & Systems, Inc.

c. MetraSeal by Metraflex Co.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material, size of pipe, and service requirements.

3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 FABRICATION

A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

B. Design hangers without disengagement of supported pipe.

C. Design roof supports without roof penetrations, flashing or damage to the roofing material.

2.9 FINISH

A. Exposed steel hangers, supports, and appurtenances shall be hot-dipped galvanized. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 INSERTS

A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Coordinate with Structural Engineer for placement of inserts.

B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

C. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. Verify with Structural Engineer prior to start of work.

3.2 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as follows:

PIPE SIZE	MAX. HANGER SPACING	HANGER DIAMETER
(Steel Pipe)		
1/2 to 1-1/4 inch	7'-0"	3/8"
1-1/2 to 3 inch	10'-0"	3/8"
4 to 6 inch	10'-0"	1/2"

8 to 10 inch	10'-0"	5/8"
12 to 14 inch	10'-0"	3/4"
15 inch and over	10'-0"	7/8"
(Copper Pipe)		
1/2 to 1-1/4 inch	5'-0"	3/8"
1-1/2 to 2-1/2 inch	8'-0"	3/8"
3 to 4 inch	10'-0"	3/8"
6 to 8 inch	10'-0"	1/2"
(Cast Iron Pipe)		
2 to 3 inch	5'-0"	3/8"
4 to 6 inch	10'-0"	1/2"
8 to 10 inch	10'-0"	5/8"
12 to 14 inch	10'-0"	3/4"
15 inch and over	10'-0"	7/8"
(PVC Pipe)		
1-1/2 to 4 inch	4'-0"	3/8"
6 to 8 inch	4'-0"	1/2"
10 inch and over	4'-0"	5/8"

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place a hanger within 12 inches of each horizontal elbow, and at the vertical to horizontal transition.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor.

G. For vertical shaft or chase applications where floor slab supported riser clamps cannot be provided to keep the pipe in alignment and to support the weight of the pipe and its contents, ensure to provide suitable fasteners, hardware, braces, unistrut, structural steel members, and appurtenances required to accommodate the pipe installation. Coordinate all such work with the project structural engineer to ensure that necessary members and attachment points are provided accordingly to bear the weight of the functioning piping.

H. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Install hangers with nut at base and above hanger; tighten upper nut to hanger after final installation adjustments.

K. Portable pipe hanger systems shall be installed per manufacturer’s instructions.

L. Distances between supports are maximum distance. Supports shall be provided to carry the pipe/equipment load.

3.3 INSULATED PIPING

A. Clamps: Attach galvanized clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.

B. Saddles: Install galvanized protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation. Secure the full contact area of the saddle to the pipe insulation with 1/8” thick coat of mastic.

C. Shields: Install protective shields MSS SP-58 Type 40 on cold and chilled water piping that has vapor barrier. Secure the full contact area of the shield to the pipe insulation with 1/8” thick coat of mastic.

D. Shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

Nominal Pipe Size	Shield Length	GaugeThickness
1/4 through 3-1/2 inch	12	18
4 inch	12	16
5 through 6 inch	18	16
8 through 14 inch	24	14
16 through 24 inch	24	12

E. Provide galvanized sheet metal shields with high density insulation insert at hangers and supports as specified in 23 07 19 - HVAC Piping Insulation.

F. High density insulation insert shall extend a minimum of 2" beyond the protective shield on each side.

G. Thermal Hanger Shields: Install where indicated, with insulation of same thickness as piping.

3.4 EQUIPMENT BASES AND SUPPORTS

A. Provide equipment bases of concrete.

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

C. Refer to specification 23 02 00 – Part 1 for anchorage requirements for roof mounted equipment.

D. Construct support of steel members. Brace and fasten with flanges bolted to structure.

E. Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 FLASHING

A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Provide curbs for mechanical roof installations that extend minimum 8 inches above adjacent roofing surface. Contact Architect for all flashing details and roof construction. Seal penetrations watertight.

3.6 SLEEVES

A. Sleeves shall be provided at the following locations:

1. Piping passing through rated and non-rated floor assemblies, rated ceiling assemblies, and roof assemblies.

2. Piping passing through concrete, masonry, and rated gypsum board walls and partitions.

3. Piping passing through exterior wall assemblies above and below grade.

4. Piping passing through non-rated gypsum board walls and partitions where indicated on the drawings or where exposed to view.

5. Piping passing through structural members where indicated on the drawings or where exposed to view.

6. Any other locations indicated on the drawings.

B. Set sleeves in position in formwork. Provide reinforcing around sleeves.

C. Extend sleeves through floors minimum one inch above finished floor level. Sleeves located in walls, ceilings, and structural members shall be flush with the outer surfaces of the assembly being penetrated.

D. Where sleeved piping penetrates a floor, ceiling, or interior wall assembly, pack annular space between pipe and sleeve with UL listed fire stopping insulation and caulk seal airtight with fire barrier sealant. Provide close fitting metal collar or escutcheon covers at both sides of wall penetrations and exposed side of ceiling penetrations.

E. Install all UL listed, prefabricated fire rated steel sleeves per the manufacturer’s installation instructions to ensure fire rating is maintained.

F. Sleeves at exterior walls below grade shall be sealed with mechanical sleeve seal. Install seal per manufacturer’s installation instructions. Select type and number of sealing elements required for pipe material, pipe size, and service requirements. Position pipe in center of sleeve. Assemble mechanical sleeve seal and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal. Locations above grade shall be provided with close fitting metal collar or escutcheon covers at both sides of penetration.

END OF SECTION

SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 WORK INCLUDED

A. Vibration and sound control products.

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of vibration control products of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Vibration and sound control products shall conform to ASHRAE criteria for average noise criteria curves for all equipment at full load conditions.

C. Unless otherwise indicated, sound and vibration control products shall be provided by a single manufacturer.

1.4 SUBMITTALS

A. SHOP DRAWINGS: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.

B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. VMC Group

B. Mason Industries, Inc.

C. Kinetics Noise Control, Inc.

D. Vibration Eliminator Co., Inc.

E. Vibro-Acoustics

2.2 GENERAL

A. Provide vibration isolation supports for equipment, piping and ductwork, to prevent transmission of vibration and noise to the building structure that may cause discomfort to the occupants.

B. Model numbers of VMC Group products are included for identification. Products of the listed manufacturers will be acceptable provided they comply with all the requirements of this specification.

2.3 FLOOR MOUNTED AIR HANDLING UNITS AND ENERGY RECOVERY UNITS

A. Provide VMC Group model CAL-2 aluminum housed isolators sized for 2” static deflection. Cast iron or steel housings may be used provided they are hot-dip galvanized after fabrication.

B. If floor mounted air handling units are furnished with internal vibration isolation option, provide VMC Group model SP-NRC, style E, consisting of two layers of 1" thick ribbed elastomeric pad bonded to a 16 gauge galvanized steel separator plate to address high frequency breakout and afford additional unit elevation for condensate drains. Ribbed elastomeric pads shall be located in accordance with the air handling unit manufacturer’s recommendations.

2.4 SUSPENDED AIR HANDLING UNITS AND ENERGY RECOVERY UNITS

A. Provide VMC Group model HRS-2 combination spring and elastomeric isolation hanger sized for 2’’ static deflection.

B. If suspended air handling units are furnished with internal vibration isolation option, provide VMC Group model HR elastomeric isolation hangers sized for approximately ½’’ deflection to address high frequency break-out.

2.5 SUSPENDED FANS AND FAN COIL UNITS

A. Provide VMC Group model HS spring hangers sized for 1’’ static deflection.

2.6 BASE MOUNTED PUMPS

A. Provide VMC Group model SP-NR, style E, elastomeric isolation pads consisting of two layers of 3/8’’ thick alternate ribbed elastomeric pad bonded to a 16 gauge galvanized steel separator plate.

B. Pads shall be sized for approximately 40 psi loading and 1/8’’ deflection.

C. Provide VMC Group model CPF, 8” concrete inertia base. Base shall be welded steel construction with concrete in-fill supplied by the contractor on site and shall incorporate standard rebar reinforcement, spaced a maximum of 12” on center. Provide VMC Group model AWH, floor mounted spring isolators sized for 1 inch static deflection.

D. Provide inertia bases for all base mounted pump applications in which the pumps are to be installed on any floor level other than the ground floor or grade level. Inertia bases shall also be provided for base mounted pump applications in which the associated mechanical room where they are housed is in a noise sensitive location, regardless of floor level.

2.7 BASE MOUNTED CHILLERS

A. Provide VMC Group model SP-NR, style E, elastomeric isolation pads consisting of two layers of 3/8'' thick alternate ribbed elastomeric pad bonded to a 16 gauge galvanized steel separator plate.

B. Pads shall be sized for approximately 40 psi loading and 1/8'' deflection.

2.8 ROOF MOUNTED CHILLERS

A. Provide VMC Group series M steel housed spring isolators with vertical uplift restraints sized for 2" static deflection.

B. Isolators to have weatherproof construction with cadmium plated springs, hot-dip galvanized housings, and zinc-electroplated hardware. Removable spring packages to include 1/4" ribbed elastomeric pad under baseplate(s).

C. Any structural steel supports provided between the top of the isolators and bottom of chiller shall be coordinated with the structural engineer.

2.9 ROOF MOUNTED COOLING TOWERS

A. Provide VMC Group series M steel housed spring isolators with vertical uplift restraints sized for 3" static deflection.

B. Isolators to have weatherproof construction with cadmium plated springs, hot-dip galvanized housings, and zinc-electroplated hardware. Removable spring packages to include 1/4" ribbed elastomeric pad under baseplate(s).

C. Steel beams between the top of the isolators and bottom of cooling tower cells shall be provided and coordinated with the structural engineer.

2.10 CONDENSING UNITS

A. Provide VMC Group model NRC, 1" thick ribbed elastomeric isolation pads sized for approximately 40 psi loading and 1/8'' deflection.

B. Pads shall be located in accordance with the condensing unit manufacturer's recommendations.

2.11 PIPING

A. Chilled water and hot water piping 1-1/2" diameter and larger in mechanical equipment rooms shall be isolated for a minimum distance of 50 feet from isolated equipment. Isolation shall be provided as follows:

1. Indoor suspended piping shall be provided with VMC Group model HRS combination spring and elastomeric isolation hangers. Isolators shall be sized for the same deflection as the isolators specified for the isolated equipment up to a maximum of 2" deflection for at least the first three piping hangers; the remaining hangers shall have isolators sized for 1" deflection.

2. Floor supported piping shall be provided with VMC Group model AW-1 open springs sized for 1'' deflection.

3. Roof mounted piping suspended from roof pipe hangers shall be provided with VMC Group model HS spring isolation hangers sized for 2" deflection.

B. All condenser water piping shall be isolated as follows:

1. Indoor suspended piping shall be provided with VMC Group model HRS combination spring and elastomeric isolation hangers sized for 1" deflection.

2. Indoor floor supported piping shall be provided with VMC Group model AW-1 open springs sized for 1" deflection.

3. Roof mounted piping supported from below shall be provided with VMC Group model AW-1 open springs sized for 1" deflection.

C. Vertical piping risers shall be provided with VMC Group model AB free standing spring isolators with elastomeric cup and friction pad installed between the floor and vertical pipe riser clamp.

D. Provide line size flexible connectors at supply and return of pumps, chillers, and all other locations indicated on the mechanical drawings and details. Flexible pipe connectors shall be VMC Group model 2800 single sphere EPDM construction and shall include 150 lb. cadmium plated carbon steel floating flanges.

2.12 CORROSION PROTECTION

A. All vibration isolators shall be designed and treated for resistance to corrosion.

B. Steel components: PVC coated or phosphate coated and painted with industrial grade enamel. Nuts, bolts, and washers: zinc-electroplated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.

B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

C. If internal isolation option is used on air handling units, the mechanical contractor shall verify proper adjustment and operation of isolators prior to start-up. All shipping brackets and temporary restraint devices shall be removed.

D. The vibration isolation supplier shall certify in writing that he has inspected the installation and that all external isolation materials and devices are installed correctly and functioning properly.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

B. Refer to Architectural Sections for additional requirements.

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

PART 2 - PRODUCTS

2.1 VALVE AND PIPE IDENTIFICATION

A. Valves:

1. All valves shall be identified with a 1-1/2" diameter brass disc wired onto the handle. The disc shall be stamped with 1/2" high depressed black filled identifying numbers. These numbers shall be numerically sequenced for all valves on the job.

2. The number and description indicating make, size, model number and service of each valve shall be listed in proper operational sequence, properly typewritten. Three copies to be turned over to Owner at completion.

3. Tags shall be fastened with approved meter seal and 4 ply 0.018 smooth copper wire. Tags and fastenings shall be manufactured by the Seton Name Plate Company or approved equal.

4. All valves shall be numbered serially with all valves of any one system and/or trade grouped together.

B. Pipe Marking:

1. All interior visible piping located in accessible spaces such as above accessible ceilings, equipment rooms, attic space, under floor spaces, etc., shall be identified with all temperature pipe markers as manufactured by W.H. Brady Company, 431 West Rock Ave., New Haven, Connecticut, or approved equal.

2. All exterior visible piping shall be identified with UV and acid resistant outdoor grade acrylic plastic markers as manufactured by Set Mark distributed by Seton (Name plate Company Factory location 20 Thompson Road, Branford, Connecticut) or approved equal.

3. Generally, markers shall be located on each side of each and every partition, on each side of every tee, on each side of every valve and/or valve group, on each side of every piece of equipment, and, for straight runs, at equally spaced intervals not to exceed 75 feet. In congested area, markers shall be placed on each pipe at the points where it enters and leaves the area and at the point of connection of each piece of equipment and automatic control valve. All markers shall have directional arrows.

4. Provide pipe markers that meet labeling requirements of ASME A13.1 for all refrigerant piping located in areas other than the room or space where the associated equipment is located. Pipe markers shall be located at intervals not exceeding 20 feet on the refrigerant piping or pipe insulation. The minimum height of the identification lettering shall be 1/2". The pipe identification shall indicate the refrigerant designation and safety group classification of the refrigerant used in the piping system. For Group A2, A3, B2, and B3 refrigerants, the identification shall also include the following statement: “DANGER – Risk of Fire or Explosion. Flammable Refrigerant.” For any Group B refrigerant, the identification shall also include the following statement: “DANGER – Toxic Refrigerant”.

5. Markers shall be installed after final painting of all piping and equipment and in such a manner that they are visible from the normal maintenance position. Manufacturer's installation instructions shall be closely followed.

6. Markers shall be colored as indicated below per ASME A13.1.

SYSTEM	COLOR	LEGEND
Chilled Water	Green	Chilled Water Supply; Chilled Water Return
Hot Water	Reddish Orange	Hot Water Supply; Hot Water Return
Condenser Water	Green	Condenser Water Supply; Condenser Water Return
Compressed Air	Blue	Compressed Air
Pneumatic Control	Yellow	Pneumatic Controls
Oxygen	Yellow	Oxygen
Nitrogen	Green	Nitrogen
Deionized Water	Green	Deionized Water
Steam	Yellow	Steam Supply; Steam Return

C. Pipe Painting:

1. All piping exposed to view shall be painted as indicated or as directed by the Architect in the field. Confirm all color selections with Architect prior to installation.

2. All piping located in mechanical rooms and exterior piping shall be painted as indicated below:

SYSTEM	COLOR
Condenser Water Supply and Return	Light Green
Chilled Water Supply and Return	Light Blue
Heating Hot Water Supply and Return	Reddish Orange

2.2 EQUIPMENT IDENTIFICATION

A. Mechanical equipment shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic or etched metal with minimum 1/2 inch high letters manufactured by Seton Company or approved equal. Submittals shall include dimensions and lettering format for approval. Attachment shall be with escutcheon pins, self-tapping screws, or machine screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All labeling equipment shall be installed as per manufacturer’s printed installation instructions.

B. Provide printable label on ceiling grids and access doors at all locations that provide access to mechanical equipment, valves, motorized dampers, and accessories located above ceiling. The label shall be white with black text with 1/4 inch high letters and shall identify the component that is accessible at that location.

C. Provide printable label on ceiling grids and access doors at all locations that provide access to fire dampers, smoke dampers, and combination fire/smoke dampers located above ceiling. The label shall be white with red text with 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, or FIRE DAMPER to identify the damper type that is accessible at that location.

D. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Contractor's price shall include all items required as per manufacturer’s requirements.

E. All piping shall be cleaned of rust, dirt, oil and all other contaminants prior to painting. Refer to Division 9 for Architect’s required paint system(s).

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 RELATED DOCUMENTS

A. Approved submittal date on equipment installed, to accomplish the test procedures, outlined under paragraph 3.01 of this Section, will be provided by the Contractor.

1.3 DESCRIPTION

A. The TAB of the air conditioning systems shall be performed by an impartial technical firm hired by the Owner whose operations are limited only to the field of professional TAB. The TAB work will be done under the direct supervision of a qualified engineer employed by the TAB firm.

B. The TAB firm will be responsible for inspecting, adjusting, balancing, and logging the date on the performance of fans, dampers in the duct system, and air distribution devices. The Contractor and the various Subcontractors of the equipment installed shall cooperate with the TAB firm to furnish necessary data on the design and proper applications of the system components and provide labor and material required to eliminate deficiencies or malperformance.

1.4 QUALITY ASSURANCE

A. QUALIFICATIONS OF CONTRACTOR PERSONNEL: Submit evidence to show that the personnel who shall be in charge of correcting deficiencies for balancing the systems are qualified. The Owner and Engineer reserve the right to require that the originally approved personnel be replaced with other qualified personnel if, in the Owner and Engineer's opinion, the original personnel are not qualified to properly place the system in condition for balancing.

B. QUALIFICATIONS OF TAB FIRM PERSONNEL:

1. A minimum of one registered Professional Engineer licensed in the State, is required to be in permanent employment of the firm.

2. Personnel used on the jobsite shall be either Professional Engineers or technicians, who shall have been permanent, full time employees of the firm for a minimum of six months prior to the start of Work for that specified project.

3. Evidence shall be submitted to show that the personnel who actually balance the systems are qualified. Evidence showing that the personnel have passed the tests required by the Associated Air Balance Council (AABC) shall be required.

C. CALIBRATION LIST: Submit to the Engineer for approval, a list of the gauges, thermometers, velometer, and other balancing devices to be used in balancing the system. Submit evidence to show that the balancing devices are properly calibrated before proceeding with system balancing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SERVICES OF THE CONTRACTOR

A. The Drawings and Specifications have indicated valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions. Install these devices in a manner that leaves them accessible, and provide access as requested by the TAB firm.

B. Have systems complete and in operational readiness prior to notifying the TAB firm that the project is ready for their services, and certify in writing to the Architect and Owner that such a condition exists.

C. As a part of the Work of this Section, make changes in the sheaves, belts, and dampers or the addition of dampers required for correct balance of the new work as required by the TAB firm, at no additional cost to the Owner.

D. Fully examine the existing system to be balanced, to determine whether or not sufficient volume dampers, balancing valves, thermometers, gauges, pressure and temperature taps, means of reading static pressure and total pressure in duct systems, means of determining water flow, and other means of taking data needed for proper water and air balancing are existing. Submit to the Engineer in writing a listing of omitted items considered necessary to balance existing systems. Submit the list and proposal as a cost add item.

E. Verify that fresh air louvers are free of blockage, coils are clean and fresh air ducts to each air handling unit have individually adjustable volume regulating dampers.

F. Provide, correct, repair, or replace deficient items or conditions found during the testing, adjusting, and balancing period.

G. In order that systems may be properly tested, balanced, and adjusted as specified, operate the systems at no expense to the Owner for the length of time necessary to properly verify their completion and readiness for TAB period.

H. Project construction schedules shall provide time to permit the successful completion of TAB services prior to Substantial Completion. Complete, operational readiness, prior to commencement of TAB services, shall include the following services of the Contractor:

1. Construction status of building shall permit the closing of doors, windows, ceilings installed and penetrations complete, to obtain project operating conditions.

2. AIR DISTRIBUTION SYSTEMS:

a. Verify installation for conformity to design. Supply, return, and exhaust ducts terminated and pressure tested for leakage as specified.

b. Volume and fire dampers properly located and functional. Dampers serving requirements of minimum and maximum outside air, return and relief shall provide tight closure and full opening, smooth and free operation.

c. Supply, return, exhaust and transfer grilles, registers and diffusers shall be installed.

d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and sealed to eliminate excessive bypass or leakage of air.

e. Fans (supply and exhaust) operating and verified for freedom from vibrations, proper fan rotation and belt tension; overload heater elements shall be of proper size and rating; record motor amperage and voltage and verify that these functions do not exceed nameplate ratings.

f. Furnish or revise fan drives or motors as necessary to attain the specified air volumes.

3. WATER CIRCULATING SYSTEMS:

a. Position valves pertinent to system design and require operation to permit full flow of water through system components. Operate hydronic systems under full flow conditions until circulating water is clean. Remove and clean strainers as required during this cycle of operation.

b. For retrofit projects, record each existing pump motor amperage and voltage. Readings shall not exceed nameplate rating.

c. Verify, on new equipment, electrical starter overload heater elements to be of proper size and rating.

d. Ensure that water circulating systems shall be full of water and free of air; expansion tanks set for proper water level, and air vents installed at high points of systems and operating freely. Advise Engineer of deficiencies.

e. Check and set operating temperatures of heat exchangers to design requirements.

f. The various existing water circulating systems, including existing strainers, shall be cleaned, filled, purged of air, and put into operation before hydronic balancing.

4. AUTOMATIC CONTROLS:

a. Verify that control components are installed in accordance with project documents and functional, electrical interlocks, damper sequences, air and water resets, fire and freeze stats.

b. Controlling instruments shall be functional and set for design operating conditions. Factory precalibration of room thermostats and pneumatic equipment will not be acceptable.

c. The temperature regulation shall be adjusted for proper relationship between the controlling instruments and calibrated by the TAB Contractor. Advise Engineer of deficiencies or malfunctions.

I. Contractor shall repair any insulation removed from piping system by TAB Contractor during water balancing.

3.2 SERVICES OF THE TAB FIRM

A. The TAB firm will act as liaison between the Owner, Engineer, and the Contractor and inspect the installation of mechanical piping system, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems being retrofitted, repaired, or added under this Contract. The reinspection of the Work will cover that part related to proper arrangement and adequate provision for the testing and balancing and will be done when the Work is 80 percent complete.

B. Upon completion of the installation and start-up of the mechanical equipment, to check, adjust, and balance system components to obtain optimum conditions in each conditioned space in the building. Prepare and submit to the Engineer complete reports on the balance and operations of the systems.

C. Measurements and recorded readings of air, water, and electricity that appear in the reports will be done by the permanently employed technicians or engineers of the TAB firm.

D. Make an inspection in the building during the opposite season from that in which the initial adjustments were made. At the time, make necessary modifications to the initial adjustments required to produce optimum operation of system components to affect the proper conditions as indicated on the Drawings. At time of opposite season check-out, the Owner's representative will be notified before readings or adjustments are made.

E. In fan systems, the air quantities indicated on the Drawings may be varied as required to secure a maximum temperature variation of two degrees within each separately controlled space, but the total air quantity indicated for each zone must be obtained. It shall be the obligation of the Contractor to furnish or revise fan drive and motors if necessary, without cost to the Owner, to attain the specified air volumes.

F. Contractor shall utilize ultrasonic flow meter to balance water flow of existing water system if the original pressure drop data is not available. Contractor shall remove insulation as necessary to use flow meter.

G. Participate in the commissioning process, which shall include but not be limited to attending commissioning meetings, coordinating work with and completing checklists as required by the commissioning team.

3.3 PROFESSIONAL REPORT

A. Before the final acceptance of the report is made, the TAB firm will furnish the Engineer the following data to be approved by the Owner and Engineer:

1. Summary of main supply, return and exhaust duct pitot tube traverses and fan settings indicating minimum value required to achieve specified air volumes.

2. A listing of the measured air quantities at each outlet corresponding to the temperature tabulation as developed by the Engineer and TAB firm.

3. Air quantities at each return and exhaust air handling device.

4. Static pressure readings entering and leaving each supply fan, exhaust fan, filter, coil, balancing dampers and other components of the systems. Including the retrofit Work. These readings will be related to performance curves in terms of the CFM handled if available.

5. Motor current readings at each equipment motor on load side of capacitors. The voltages at the time of the reading shall be listed.

6. The final report shall certify test methods and instrumentation used, final velocity reading obtained, temperatures, pressure drops, RPM of equipment, amperage of motors, air balancing problems encountered, recommendations and uncompleted punch list items. The test results will be recorded on standard forms.

7. A summary of actual operating conditions shall be included with each system outlining normal and ventilation cycles of operation. the final report will act as a reference of actual operating conditions for the Owner's operating personnel.

3.4 BALANCING AIR CONDITIONING SYSTEM

A. GENERAL:

1. Place all equipment into full operation, and continue operating during each working day of balancing and testing. If the air conditioning system is balanced during Off-Peak cooling season Contractor shall return to rebalance air side system as required to put system in proper balance at that season.

2. The Contractor shall submit detailed balancing and recording forms for approval. After approval by the Engineer, prepare complete set of forms for recording test data on each system. All Work shall be done under the supervision of a Registered Professional Engineer. All instruments used shall be accurately calibrated to within 1% of scale and maintained in good working order.

3. Upon completion of the balancing and testing, the TAB Contractor shall compile the test data in report forms, and forward five copies to the Engineer for evaluation.

4. The final report shall contain logged results of all tests, including such data as:

a. Tabulation of air volume at each outlet.

b. Outside dry bulb and wet bulb temperature.

c. Inside dry bulb and wet bulb temperatures in each conditioned space room or area.

d. Actual fan capacities and static pressures. Motor current and voltage readings at each fan.

B. AIR SYSTEMS: Perform the following operations as applicable to balance and test systems:

1. Check fan rotation.

2. Check filters (balancing shall be done with clean filters).

3. Test and adjust blower rpm to design requirements.

4. Test and record motor full load amperes.

5. Test and record system static pressures, suction and discharge.

6. Test and adjust system for design cfm, return air and outside air (±2%). Change-out fan sheaves as required to balance system.

7. Test and record entering air temperatures, db and wb.

8. Test and record leaving air temperatures, db and wb.

9. Adjust all zones to design cfm (±2%).

10. Test and adjust each diffuser, grille, and register to within 5% of design.

C. AIR DUCT LEAKAGE: (From SMACNA Duct Standards latest edition) Test all ductwork (designed to handle over 1000 CFM) as follows:

1. Test apparatus

a. The test apparatus shall consist of:

b. A source of high pressure air - a portable rotary blower or a tank type vacuum cleaner.

c. A flow measuring device consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly shall be accurately calibrated with its own calibration curve. Pressure and flow readings shall be taken with U-tube manometers.

2. Test Procedures

a. Test for audible leaks as follows:

1) Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.

2) Start the blower with its control damper closed.

3) Gradually open the inlet damper until the duct pressure reaches 1.5 times the standard designed duct operating pressure.

4) Survey all joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.

b. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:

1) Start blower and open damper until pressure in duct reaches 50% in excess of designed duct operating pressure.

2) Read the pressure differential across the orifice on manometer No. 2. If there is no leakage, the pressure differential will be zero.

3) Total allowable leakage shall not exceed one (1) percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

4) Even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak which must be corrected.

D. DX SYSTEMS:

1. Test and record suction and discharge pressures at each compressor and record ambient air temperature entering the condensing coils.

2. Test and record unit full load amps and voltage.

3. Test and record staging and unloading of unit required by sequence of operation or drawing schedule.

E. Automatic temperature controls shall be calibrated; and all thermostats and dampers adjusted so that the control system is in proper operating condition, subject to the approval of the Engineer/Owner.

F. The TAB Contractor shall report to Engineer all air distribution devices or other equipment that operate noisily so that corrective measures may be implemented by the Contractor at no additional cost to the Owner or Architect/Engineer.

END OF SECTION

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 WORK INCLUDED

A. External Duct Insulation

1. Fiberglass / Glass Mineral Fiber Flexible Blanket Insulation
2. Fiberglass / Glass Mineral Fiber Rigid Board Insulation
3. Fiberglass / Glass Mineral Fiber Segmented Board Pipe and Tank Insulation
4. Fiberglass / Glass Mineral Fiber Continuous Mat Pipe and Tank Insulation
5. Fire-Rated High-Temperature Ceramic Fiber Flexible Blanket Insulation

B. Internal Duct Insulation

1. Fiberglass / Glass Mineral Fiber Flexible Duct Liner Insulation
2. Fiberglass / Glass Mineral Fiber Rigid Plenum Liner Insulation

C. Field-applied protective finishes

D. Adhesives

E. Mastics

F. Lagging Adhesives

G. Sealants

H. Glass Fiber Fabric Reinforcing Mesh

I. Securements

1.3 RELATED SECTIONS

A. Section 23 05 29 - Hangers and Supports for Piping and Equipment - HVAC

B. Section 23 05 53 - Identification for HVAC Piping and Equipment

C. Section 23 31 13 - Metal Ductwork

1.4 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.

B. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2025a.

D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

E. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2023.

F. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2023, with Editorial Revision (2024).

G. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

H. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.

I. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.

J. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2025.

K. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.

L. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2016 (Reapproved 2021).

M. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings; 2025.

N. ASTM C1393 - Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks; 2019.

O. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation; 2021.

P. ASTM C1767 - Standard Specification for Stainless Steel Jacketing for Insulation; 2021.

Q. ASTM D1644 - Standard Test Methods for Nonvolatile Content of Varnishes; 2001.

R. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

S. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

T. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2026.

U. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.

V. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2024.

W. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems; 2025.

X. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

Y. ASTM G22 - Standard Practice for Determining Resistance of Plastics to Bacteria; 2023.

Z. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

AA. MIL-DTL-3316 - Adhesives, Fire-Resistant, Thermal Insulation; 2020d (Validated 2025).

BB. NACIIS - North American Commercial and Industrial Insulation Standards Manual; current edition.

CC. NAIMA FGDLS - North American Insulation Manufacturers Association (NAIMA) Fibrous Glass Duct Liner Standards; Current Edition, Including All Revisions.

DD. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

EE. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

FF. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

GG. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

HH. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

II. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.

JJ. UL 2824 - GREENGUARD Certification Program Method for Measuring Microbial Resistance from Various Sources Using Static Environmental Chambers; Current Edition, Including All Revisions.

1.5 QUALITY ASSURANCE

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

B. All insulation shall be listed and labeled to have a composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to insulation) flame spread index of not more than 25 and smoke-developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723.

1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

C. Duct and plenum insulation shall comply with minimum R-value requirements of ICC (IECC) and ASHRAE Std 90.1 I-P unless greater values are indicated otherwise in the contract documents.

D. Adhesive and other insulation materials shall comply with NFPA 90A and NFPA 90B. Additionally, all adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) shall be comprised of low-emitting materials that comply with VOC limits prescribed by SCAQMD 1168.

E. Vapor retarder mastics used on the interior of the building shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D

F. Insulations shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.

G. Fiberglass insulations shall have a minimum of 50 percent recycled glass content.

H. Fiberglass insulations shall be UL GREENGUARD Gold certified.

1.6 WARRANTY

A. Warrant the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from either defective, or nonconforming materials and workmanship.

B. Defects shall include, but not be limited to, the following:

1. Mildewing.

2. Peeling, cracking, and blistering.

3. Condensation on exterior surfaces.

1.7 SUBMITTALS

A. SHOP DRAWINGS: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.

B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation materials to site in unopened containers with manufacturer's product name, ASTM standard designation, type and grade, maximum use temperature, nominal dimensions, manufacturer lot or date code.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove such from project site.

C. Store insulation indoors and keep free from exposure to UV and precipitation.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

A. The type of insulation and its installation shall be in strict accordance with these specifications for each service, and the application technique shall be as recommended by the manufacturer. All insulation types, together with adhesives and finishes shall be submitted and approved before any insulation is installed.

B. A sample quantity of each type of insulation and each type of application shall be installed and approval secured prior to proceeding with the main body of the Work.

2.2 ACCEPTABLE MANUFACTURERS

A. Fiberglass/Glass mineral fiber materials shall be as manufactured by Knauf Insulation, Certain-Teed, Johns-Manville or Owens-Corning and shall have the same thermal properties, density, fire rating, vapor retarder, etc., as the types specified herein, subject to review by the Engineer.

B. Adhesives, mastics, and sealants shall be as manufactured by 3M Company, Carlisle/Hardcast, Design Polymerics, Foster/Childers, Mon-Eco Industries, or Vimasco Corporation and shall have the same adhesive properties, fire rating, vapor seal, etc., as the types specified herein, subject to review by the Engineer.

C. Ceramic fiber materials shall be as manufactured by 3M Company, Alkegen/Unifrax, or Morgan Advanced Materials/Thermal Ceramics.

D. Metal jacketing and fitting covers shall be as manufactured by Johns Manville or RPR Products, Inc.

2.3 EXTERNAL INSULATIONS

A. Fiberglass / Glass Mineral Fiber Flexible Blanket Insulation: Glass fibers bonded with a thermosetting resin, complying with ASTM C1290 and ASTM C553, Type I, II, and III. Provide insulation with factory applied FSK vapor retarding facing complying with ASTM C1136, Type I, II, VIII, X. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.27 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 250 degrees F with facing, 350 degrees F for unfaced material. Provide Knauf Insulation Performance+ Duct Wrap with ECOSE Technology, Johns Manville Microlite FSK or approved equal.

B. Fiberglass / Glass Mineral Fiber Rigid Board Insulation: Glass fibers bonded with a thermosetting resin, complying with ASTM C553 Type I, II, III, ASTM C612 Type IA, IB. Provide insulation with factory applied FSK facing vapor retarder facing complying with ASTM C1136, Type I, II. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.24 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 450 degrees F. Provide Knauf Insulation Earthwool Insulation Board with ECOSE Technology, Johns Manville 800 Series Spin-Glas or approved equal.

C. Fiberglass / Glass Mineral Fiber Segmented Board Pipe and Tank Insulation: Glass fibers bonded with a thermosetting resin, complying with ASTM C1393, Category 1. Semi-rigid, segmented board in roll form with glass fibers adhered perpendicular to the vapor retarder facing. Provide insulation with factory applied FSK vapor retarder facing complying with ASTM C1136, Type II, IV, X. Compressive strength per ASTM C165 C165, not less than 120 PSF at 10% deformation. Thermal conductivity (k-value) at 100 degrees F mean temperature shall be 0.26 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 850 degrees F. Provide Knauf Insulation Earthwool Pipe & Tank Insulation with ECOSE Technology or approved equal.

D. Fiberglass / Glass Mineral Fiber Continuous Mat Pipe and Tank Insulation: Glass fibers bonded with a thermosetting resin, complying with ASTM C1393; Type I, II, IIIA, IIIB Category 2. Semi-rigid, continuous mat in roll form. Provide insulation with factory applied FSK vapor retarder facing complying with ASTM C1136, Type II, IV, X. Compressive strength per ASTM C165, not less than 25 PSF at 10% deformation. Thermal conductivity (k-value) at 100 degrees F mean temperature shall be 0.25 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 850 degrees F. Provide Knauf Insulation KwikFlex Pipe & Tank Insulation, Johns Manville Micro-Flex or approved equal.

E. Fire-Rated High-Temperature Ceramic Fiber Flexible Blanket Insulation: High-temperature ceramic fiber blanket thermal insulation encapsulated in a fiberglass reinforced aluminized polyester foil. Fire-rated blanket insulation shall have a nominal thickness of 1-1/2” and a nominal density of 6.0 pcf. Provide 3M Fire Barrier Duct Wrap 615+, Alkegen/Unifrax FyreWrap Elite 1.5, or Morgan Advanced Materials/Thermal Ceramics FireMaster FastWrap XL.

2.4 INTERNAL INSULATIONS

A. Fiberglass / Glass Mineral Fiber Flexible Duct Liner Insulation: Rotary glass fibers bonded with thermosetting resin, complying with ASTM C1071 Type I. Airstream side to have a tightly bonded, black mat finish withstanding maximum rated air velocity of 6,000 ft/minute. Mat finish shall be treated with EPA-registered biocide for use in HVAC systems and verified to be microbially resistant in accordance with ASTM G21, ASTM G22, ASTM C1338, and UL 2824. The outer edges of the Liner shall have a factory applied encapsulating coating. Nominal density shall be 1.5 pcf minimum and when tested in accordance with ASTM C423 (Type A Mounting), shall provide a Noise Reduction Coefficient of 0.70 at 1.0”, 0.80 at 1.5”, and 0.95 at 2.0” thickness. Maximum service temperature of 250 degrees F. Thermal Conductivity (k-value) at 75 degrees F mean temperature shall be 0.24 Btu x in. /h x sq. ft. x degrees F, or less. Provide Knauf Insulation Performance+ Duct Liner with ECOSE Technology, Johns Manville Linacoustic RC or approved equal.

B. Fiberglass / Glass Mineral Fiber Rigid Plenum Liner Insulation: Glass fibers bonded with thermosetting resin, complying with ASTM C1071 Type II. Airstream side to have a tightly bonded, black mat finish withstanding maximum rated air velocity of 5,000 ft/minute. Mat finish shall be treated with EPA-registered biocide for use in HVAC systems and verified to be microbially resistant in accordance with ASTM G21 and ASTM C1338. The outer edges of the Liner shall have a factory applied encapsulating coating. Nominal density shall be 3.0 pcf minimum and when tested in accordance with ASTM C423 (Type A Mounting), shall provide a minimum Noise Reduction Coefficient of 0.65 at 1.0", 0.85 at 1.5", at 0.95 at 2.0" thickness. Maximum service temperature of 250 degrees F. Thermal Conductivity (k-value) at 75 degrees F mean temperature shall be 0.23 Btu x in. /h x sq. ft. x degrees F, or less. Provide Knauf Insulation Performance+ Rigid Plenum Liner with ECOSE Technology, Johns Manville Linacoustic R-300 or approved equal.

2.5 FIELD-APPLIED PROTECTIVE FINISHES

A. METAL JACKETING: Provide aluminum jacketing complying with ASTM C1729 or stainless steel jacketing complying with ASTM C1767. Metal jacketing shall have a minimum thickness of 0.016 inches.

2.6 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Fiberglass / Glass Mineral Fiber Adhesive: Comply with MIL-DTL-3316C, Class 2, Grade A. Provide Childers CP-82 or approved equal.

C. Duct Liner Adhesive: Duct Liner adhesives shall comply with ASTM C916.

2.7 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic: Water based; suitable for indoor and outdoor use on below ambient services. Water-Vapor Permeance shall be 0.09 perms at 55-mils dry film thickness when tested in accordance with ASTM E96/E96M, Procedure A. Service Temperature Range shall be -20 to +180 degrees F. Solids content shall be 59 percent by volume and 71 percent by weight per ASTM D1644. Provide Childers CP-35 or approved equal.

2.8 LAGGING ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation. Service Temperature Range shall be 0 to +180 degrees F. Provide Childers CP-52 or approved equal.

2.9 SEALANTS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. FSK and Metal Jacket Flashing Sealants shall be fire and water-resistant, flexible, elastomeric sealants with a service temperature range of -40 to +250 degrees F. Provide Childers CP-76 or approved equal.

C. Fire Barrier Sealant shall be a latex-based, intumescent sealant that dries to form a monolithic firestop seal. Fire barrier sealant shall be firestop tested up to 4 hours in accordance with ASTM E814 and fire resistance tested in accordance with ASTM E1966. Provide 3M CP 25WB+ or approved equal.

2.10 GLASS FIBER FABRIC REINFORCING MESH

A. Woven Glass Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch. Provide Childers Chil-Glas No. 10 or approved equal.

2.11 SECUREMENTS

A. Bands

1. Approved Manufacturers

a. Johns Manville

b. RPR Products

2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.

3. Aluminum: ASTM B209/B209M, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.

4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins

1. Approved Manufacturers

a. AGM Industries, Inc.

b. Midwest Fasteners, Inc.

c. GEMCO

d. Duro-Dyne

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

3. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, minimum 0.106-inch-diameter shank, length to suit depth of insulation indicated.

4. Insulation Retaining Washers: Self-locking washers formed from 0.016 inch thick, galvanized steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Staples

1. Outward-clinching insulation staples, nominal 1/2-inch-wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 GENERAL

A. To ensure that external fiberglass/glass mineral fiber flexible blanket and rigid board insulation will achieve its highest possible performance and serve its intended purpose, install all mechanical insulation materials and associated accessories in accordance with manufacturer’s published instructions and industry practices detailed by the NACIIS Manual as published by the Midwest Insulation Contractors Association (MICA).

B. To ensure that internal fiberglass/glass mineral fiber flexible duct and rigid plenum liner insulation will achieve its highest possible performance and serve its intended purpose, install duct liner, plenum liner, and all associated accessories in accordance with manufacturer’s published instructions and industry practices detailed by NAIMA FGDLS and SMACNA (DCS).

C. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

D. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of, ducts and fittings.

E. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

3.2 EXTERNAL DUCT INSULATION

A. Fasten all longitudinal and circumferential laps with outward clinching staples 3" on center. On rectangular ducts over 24" wide apply as above and hold insulation in place on bottom side with mechanical pins and clips on 12" centers.

B. Seal all joints, fastener penetrations and other breaks in vapor retarder with 3-inch wide strips of glass fiber fabric reinforcing mesh embedded between two coats of vapor retarder mastic.

C. External duct wrap is required on all outside air ducts, supply and return air ducts that are not internally insulated. External duct wrap is also required on all exhaust and relief air ducts that are used in airside energy recovery systems. Provide external duct wrap on exhaust and relief duct sections between shutoff or relief dampers and exterior wall or roof penetrations. Any exhaust ductwork located in an unconditioned space that conveys air from conditioned spaces or vice versa shall be provided with external duct wrap. Duct wrap shall be provided as follows:

1. 1½” thick, 1.0 pcf density minimum; minimum installed R-value of 4.5 when ducts are located in directly conditioned spaces.

2. 2” thick, 1.0 pcf density minimum; minimum installed R-value of 6.0 when ducts are located in indirectly conditioned spaces such as ceiling plenum space used for return air or located indoors concealed within chases or shafts.

3. 3" thick, 0.75 pcf density minimum; minimum installed R-value of 8.3 when ducts are located in unconditioned spaces.

D. Any ductwork located in an air plenum that is comprised of materials that do not comply with the 25/50 flame and smoke rating per ASTM E84 or UL 723 testing requirements or UL 2043 for discrete products in plenums shall be provided with a single layer of duct wrap to establish a noncombustible rating per ASTM E136. Duct wrap products which are approved for such non-compliant combustible duct materials located in air plenums shall be 3M Fire Barrier Plenum Wrap 5A+ or Alkegen/Unifrax FyreWrap 0.5 Plenum. Insulation products for this application shall be installed in strict accordance with the manufacturer’s instructions.

3.3 DUCT LINER

A. Duct liner shall be kept clean and dry during transportation, storage, installation, and throughout the construction process care should be taken to protect the liner from exposure to the elements or damage from mechanical abuse.

B. Duct liner shall be adhered to the sheet metal with a full coverage of approved adhesive complying with ASTM C916. All exposed leading edges and transverse joints shall be coated with factory-applied or field-applied edge coating, Childers CP-50A HV2 Black or approved equal and shall be neatly butted without gaps. Shop or field cuts shall be liberally coated with an edge coating. All coatings and adhesives shall be designed for duct liner application.

C. Metal nosings shall be securely installed over transversely oriented liner edges facing the airstream at forward discharge and at any point where lined duct is preceded by unlined duct.

D. When velocity exceeds 4,000 fpm (20.3 m/sec), use metal nosing on every leading edge. Nosing may be formed on duct or be channel or zee attached by screws, rivets or welds.

E. Secure duct liner with mechanical fasteners that are adhered, weld-secured or impact-driven to hold to the duct metal, with retaining washers or integral cupped heads. Provide a minimum of 1 row of pins per duct side. Pin according to NAIMA FGDLS pinning schedule.

F. Line supply and return ductwork at connection of fan-powered HVAC units to a point of 15 feet upstream and downstream of the equipment, 15 feet downstream of fan powered terminal units, and in return air boots.

G. Duct liner shall be provided as follows:

1. 1” thick, 1.5 pcf density minimum, with a minimum installed R-value of 4.2 when ducts are located in directly conditioned spaces.

2. 1 ½” thick, 1.5 pcf density minimum, with a minimum installed R-value of 6.0 when ducts are located in indirectly conditioned spaces such as ceiling plenum space used for return air.

3. 2” thick, 1.5 pcf density minimum, with a minimum installed R-value of 8.0 when ducts are located in indoor, unconditioned spaces or located outdoors.

4. 1 ½” thick, 3.0 pcf density minimum, with a minimum R-value of 6.3 for rigid plenum liner applications.

3.4 EXPOSED DUCTWORK LOCATED INDOORS

A. Duct required to be insulated by any section of this specification that is routed exposed in occupied spaces shall be double wall.

B. Duct routed exposed shall be double wall with perforated inner liner and fiberglass/glass mineral fiber insulation. Provide 1” thick insulation when ductwork is located in conditioned spaces and 2” thick in unconditioned spaces, insulation density shall be a minimum of 1.0 pcf. Double wall duct shall be United McGill model Acousti-k27 for round or oval ducts and Rectangular-k27 for rectangular ducts or approved equal.

3.5 EXPOSED DUCT LOCATED OUTDOORS OR IN UNINHABITED CRAWLSPACES

A. All rectangular metal ductwork located outdoors or in uninhabited crawlspaces shall be internally lined with fiberglass Duct Liner as specified and externally insulated with 2" thick, 6.0 pcf density fiberglass insulation board with FSK facing. The protective finish system shall be secured metal jacketing.

B. All round and flat oval metal ductwork located outdoors or in uninhabited crawlspaces shall be internally lined with fiberglass Duct Liner as specified and externally insulated with 2" thick fiberglass pipe and tank insulation with FSK facing. The protective finish system shall be secured metal jacketing.

C. Paint non-insulated duct. Coordinate color with Architect.

3.6 AIR DEVICE AND MISCELLANEOUS DUCT INSULATION

A. The backside of all supply air devices shall be insulated with taped and sealed external duct wrap matching the thickness, density, and R-value of the associated duct system.

B. The contractor shall install an additional layer of 1-½ inch thick external fiberglass / glass mineral fiber duct wrap on any portion of the supply air, return air, outside air, or exhaust air system that has condensation forming during any period of operation. The insulation shall be taped and vapor-sealed and located until all evidence of the condensation has been eliminated, at no additional cost to the Owner.

3.7 FIRE RATED ASSEMBLY PENETRATIONS

A. Terminate insulation at fire damper sleeves for fire rated assembly penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

B. Seal penetrations through fire rated assemblies with an approved fire barrier sealant. Refer to Division 7 for further requirements regarding “"Through-Penetration Firestop Systems”.

3.8 KITCHEN GREASE HOOD EXHAUST DUCT

A. All type I kitchen range hood exhaust duct shall be enclosed with 2-hour fire rated enclosure.

B. The duct enclosure shall be sealed around the duct at the points of penetration with an approved fire barrier sealant. Refer to Division 7 for further requirements regarding “"Through-Penetration Firestop Systems”.

C. The enclosure shall be separated from the duct by at least 3 inches and not more than 12 inches.

D. Cleanout openings at exhaust duct with access openings at the fire rated enclosure and access doors shall be provided at each duct offset and as required for proper operation and maintenance.

E. As an alternate method, the contractor may use two layers of 2-hour Fire-Rated High-Temperature Ceramic Fiber Flexible Blanket Insulation in lieu of the fire rated enclosure, provided that all the following constraints are satisfied:

1. Duct insulation system shall be tested per ASTM E2336 internal fire testing and have an achieved minimum fire resistance rating of 2 hours.

2. Product shall be approved by the local Authority Having Jurisdiction (AHJ).

3. Duct wrap system shall be mechanically attached to the duct using steel banding and/or weld pins per manufacturer’s instructions.

4. Duct wrap system shall be installed in strict accordance with the manufacturer’s instructions, including but not limited to zero clearance to combustibles at all locations on the wrap surface.

F. Insulation and all other requirements shall be provided per local codes.

3.9 DRYER VENT DUCT

A. All dryer vent duct routed within an air plenum shall be enclosed within a 1-hour fire rated enclosure.

B. The duct enclosure shall be sealed around the duct at the points of penetration with an approved fire barrier sealant. Refer to Division 7 for further requirements regarding "Through-Penetration Firestop Systems".

C. The enclosure shall be separated from the duct by at least 3 inches and not more than 12 inches.

D. Cleanout openings at exhaust duct with access openings at the fire rated enclosure and access doors shall be provided at each duct offset and as required for proper operation and maintenance.

E. As an alternate method, the contractor may use a single layer of 1-hour Fire-Rated High-Temperature Ceramic Fiber Flexible Blanket Insulation in lieu of the fire rated enclosure, provided that all the following constraints are satisfied:

1. Duct insulation system shall be tested per ASTM E2336 internal fire testing and have an achieved minimum fire resistance rating of 1 hour.

2. Product shall be approved by the local Authority Having Jurisdiction (AHJ).

3. Duct wrap system shall be mechanically attached to the duct using steel banding and/or weld pins per manufacturer's instructions.

4. Duct wrap system shall be installed in strict accordance with the manufacturer's instructions, including but not limited to zero clearance to combustibles at all locations on the wrap surface.

F. Insulation and all other requirements shall be provided per local codes.

END OF SECTION

SECTION 23 07 16 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for Owner's use.

B. Work specified elsewhere.

1. Basic materials and methods.

2. Piping systems.

3. Air distribution equipment.

1.3 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.

D. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

F. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

I. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

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

B. All insulation shall be listed and labeled to have a composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to insulation) flame spread index of not more than 25 and smoke-developed index of not more than 50 when tested in accordance with ASTM E84 and UL 723.

C. All HVAC equipment insulation shall comply with minimum requirements of ICC (IECC) and ASHRAE Std 90.1 I-P.

D. Adhesives and other materials shall comply with NFPA 90A and NFPA 90B. Additionally, all adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) shall be comprised of low-emitting materials that comply with VOC limits prescribed by SCAQMD 1168.

1.5 WARRANTY

A. Warrant the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.

B. Defects shall include, but not be limited to, the following:

1. Mildewing.

2. Peeling, cracking, and blistering.

3. Condensation on exterior surfaces.

1.6 SUBMITTALS

A. SHOP DRAWINGS: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.

B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.

1.7 DELIVERY AND STORAGE

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in unopened containers with manufacturer's stamp, clearly labeled with flame and smoke rating, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation; remove such from project site.

PART 2 - PRODUCTS

2.1 EQUIPMENT INSULATION

A. It is the intent of these specifications to secure superior quality workmanship resulting in an absolutely satisfactory installation of insulation from the standpoint of both function and appearance. Particular attention shall be given to valves, fittings, pumps, etc., requiring low temperature insulation to insure full thickness of insulation and proper application of the vapor seal. All flaps of vapor barrier jackets and/or canvas covering must be neatly and securely smoothed and sealed down.

B. The type of insulation and its installation shall be in strict accordance with these specifications for each service, and the application technique shall be as recommended by the manufacturer. All insulation types, together with adhesives and finishes shall be submitted and reviewed before any insulation is installed.

C. A sample quantity of each type of insulation and each type application shall be installed and reviewed prior to proceeding with the main body of the work. Condensation caused by improper installation of insulation shall be corrected by Installing Contractor. Any damage caused by condensation shall be made good at no cost to the Owner or Architect/Engineer.

D. Glass mineral wool materials as manufactured by Knauf Insulation, Owens/Corning, Certain-Teed or Johns Manville will be acceptable, if they comply with the specifications.

E. Accessories, such as adhesives, mastics and cements shall have the same component ratings as listed above. Additionally, all adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) shall be comprised of low-emitting materials that comply with VOC limits prescribed by SCAQMD 1168.

F. All products or their shipping cartons shall have a label affixed, indicating flame and smoke ratings do not exceed the above requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All insulation shall be installed in accordance with the manufacturer’s recommendations and printed installation instructions.

B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer’s requirements.

3.2 CHILLED WATER PUMPS

A. Shall be insulated with Knauf Insulation Board with ECOSE Technology, Certain-Teed IB-600 or equal, rigid insulation board, 2" thick, cut and formed into a box and secured in place with 3/4" wide x 0.020 galvanized bands spaced on 9" centers. Bands shall be pulled snug over sheets of insulation board. All joints shall be well and neatly fitted and so arranged that the assembly may be dismantled with ease permitting access to the pump. All voids on the interior of box shall be filled with glass mineral wool blanket insulation. Exterior shall be finished with a trowel coat of Foster's 30-35 vapor barrier mastic, a layer of 1" mesh galvanized wire, and a coat of Johns Manville CALCOAT-127 finishing cement. Final finish shall be an eight ounce canvas jacket, pasted and sealed in place with Foster's 30-36 Seafas.

B. Insulation Board shall comply with ASTM C612 and ASTM C553. The associated FSK facing shall comply with ASTM C1136.

C. Pipe insulation shall be extended over all cold parts of chilled water pumps not directly over drainage basin of pump base.

3.3 BOILER EXHAUST SYSTEM

A. Insulate boiler stack, breaching and induced draft fan housing in contact with flue gases, with 1-inch thick high temperature, spun glass mineral wool semi-rigid board. Knauf Insulation Elevated Temperature Board with ECOSE Technology, Johns-Manville 1000 Spin-Glass or approved equal, secured between outer facing of 1-inch galvanized wire mesh. Calcium silicate insulation, Johns-Manville Thermo-1200 or approved equal, may be applied at the contractor's option followed by application of 1-inch galvanized wire mesh.

B. In exposed areas, apply 1 1/4-inch coat of insulating and finishing cement, Ryder "V" One Coat or approved equal, troweled to a smooth surface. After cement has dried, surfaces shall be weatherproofed using 2 coats of mastic, Childers CP-10, with a layer of white glass cloth reinforcing embedded between coats.

C. Insulation Board for elevated temperature applications shall comply with ASTM C612.

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for Owner's use.

B. Furnish and install piping insulation to:

1. Chilled water and heating hot water piping.
2. Steam and steam condensate piping.
3. Condensate drain piping.
4. Refrigerant piping.
5. Stand-by generator engine exhaust piping.
6. All pipes subject to freezing conditions shall be insulated.

C. Work specified elsewhere.

1. Painting.
2. Pipe hangers and supports.

D. For insulation purpose piping is defined as the complete piping system including supplies and returns, pipes, valves, automatic control valve bodies, fittings, flanges, strainers, thermometer well, unions, reducing stations, and orifice assemblies.

1.3 RELATED SECTIONS

A. Section 23 05 29 - Hangers and Supports for Piping and Equipment - HVAC

B. Section 23 05 53 - Identification for HVAC Piping and Equipment

C. Section 23 21 13 - Above Ground Hydronic Piping

D. Section 23 23 00 - Refrigerant Piping

1.4 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.

B. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2023.

D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

E. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation; 2019.

F. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).

G. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

H. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.

I. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2022.

J. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

K. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.

L. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2024.

M. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.

N. ASTM C1393 - Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks; 2019.

O. ASTM C1617 - Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals; 2019.

P. ASTM C1710 - Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form; 2022.

Q. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation; 2021.

R. ASTM C1767 - Standard Specification for Stainless Steel Jacketing for Insulation; 2021.

S. ASTM D1644 - Standard Test Methods for Nonvolatile Content of Varnishes; 2001.

T. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

U. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

V. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2026.

W. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.

X. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2024.

Y. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

Z. MIL-A-24179 - Adhesive, Flexible Unicellular-Plastic Thermal Insulation; 1969a (Validated 2026).

AA. MIL-DTL-3316 - Adhesives, Fire-Resistant, Thermal Insulation; 2020d (Validated 2025).

BB. NACIIS - North American Commercial and Industrial Insulation Standards Manual; current edition.

CC. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2024, with Amendment.

DD. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

EE. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

FF. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

GG. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

HH. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.

1.5 QUALITY ASSURANCE

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

B. All insulation shall be listed and labeled to have a composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to insulation) flame spread index of not more than 25 and smoke-developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723.

1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

C. All HVAC piping insulation thicknesses shall comply with ICC (IECC) and ASHRAE Std 90.1 I-P.

D. Accessories, such as adhesives, mastics and cements shall have the same component ratings as listed above. Additionally, all adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) shall be comprised of low-emitting materials that comply with VOC limits prescribed by SCAQMD 1168.

E. Adhesives, mastics, and sealants used on the interior of the building shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D

F. All insulations shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.

G. All insulations shall be UL GREENGUARD Gold certified.

H. Insulation materials applied to carbon steel shall be Mass Loss Corrosion Rate (MLCR) tested per ASTM C1617.

I. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

J. Fiberglass insulations shall have a minimum of 50 percent recycled glass content.

K. Foam insulation materials shall be manufactured without the use of chlorofluorocarbon (CFC) or hydrochlorofluorocarbon (HCFC) blowing agents.

1.6 WARRANTY

A. Warrant the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials or workmanship.

B. Defects shall include, but not be limited to, the following:

1. Mildewing.

2. Peeling, cracking, and blistering.

3. Condensation on exterior surfaces.

1.7 SUBMITTALS

A. SHOP DRAWINGS: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.

B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, project variations, and accessories.

1.8 DELIVERY AND STORAGE

A. Deliver insulation materials to site in unopened containers with manufacturer's product name, ASTM standard designation, type and grade, maximum use temperature, nominal dimensions, manufacturer lot or date code.

B. Protect insulation against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation; remove such from project site.

C. Store insulation indoors and keep free from exposure to UV and precipitation.

PART 2 - PRODUCTS

2.1 HVAC PIPING INSULATION

A. It is the intent of these specifications to secure superior quality workmanship resulting in an absolutely satisfactory installation of insulation from the standpoint of both function and appearance. Particular attention shall be given to valves, fittings, pumps, etc., requiring low temperature insulation to insure full thickness of insulation and proper application of the vapor seal. All flaps of vapor barrier jackets and/or canvas covering must be neatly and securely smoothed and sealed down.

B. The type of insulation and its installation shall be in strict accordance with these specifications for each service, and the application technique shall be as recommended by the manufacturer. All insulation types, together with adhesives and finishes shall be submitted and reviewed prior to installation.

C. A sample quantity of each type of insulation and each type application shall be installed and accepted prior to proceeding with the main body of the work. Condensation caused by improper installation of insulation shall be corrected by Installing Contractor. Any damage caused by condensation shall be made good at no cost to the Owner or Architect/Engineer.

D. Any existing piping located in an air plenum that is comprised of materials that do not comply with the 25/50 flame and smoke rating per ASTM E84 testing requirements shall be provided with a single layer of high-temperature insulation to establish a noncombustible rating per ASTM E136. Insulation products which are approved for such non-compliant combustible piping materials located air plenums shall be 3M Fire Barrier Plenum Wrap 5A+ or Unifrax FyreWrap 0.5 Plenum. Insulation products for this application shall be installed in strict accordance with the manufacturer's instructions.

2.2 APPROVED MANUFACTURERS

A. Calcium silicate materials shall be as manufactured by Johns Manville.

B. Fiberglass/glass mineral fiber materials shall be as manufactured by Knauf Insulation, Johns Manville or Owens-Corning and shall have the same thermal properties, density, fire rating, vapor barrier, etc., as the types specified herein, subject to review by the Engineer.

C. Adhesives, mastics, and sealants shall be as manufactured by 3M Company, Armacell, Foster/Childers, Mon-Eco Industries, or Vimasco Corporation and shall have the same adhesive properties, fire rating, vapor seal, etc., as the types specified herein, subject to review by the Engineer.

D. Flexible elastomeric cellular thermal insulation shall be as manufactured by Armacell.

E. Phenolic foam insulation shall be as manufactured by Resolco, Inc. (Insul-Phen) or Polyguard (Poly-phen).

F. Metal jacketing and fitting covers shall be as manufactured by Johns Manville or RPR Products.

2.3 MATERIALS

A. CHILLED WATER PIPING: Provide phenolic foam in accordance with ASTM C1126 type III with ASJ vapor retarder jacket and all joints sealed. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.18 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 250 degrees F.

B. HEATING WATER PIPING: Provide fiberglass/glass mineral fiber preformed pipe insulation in accordance with ASTM C547, Type I and IV; ASTM C585, ASTM C411, and ASTM C795 with ASJ+ SSL+ vapor retarder jacket complying with ASTM C1136. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.23 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 1,000 degrees F. Provide Knauf Insulation Earthwool 1000 Insulation with ECOSE Technology or approved equal or phenolic foam in accordance with ASTM C1126 type III with ASJ vapor retarder jacket and all joints sealed. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.18 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 250 degrees F.

C. LARGE DIAMETER PIPING (>24.0” Dia.): Provide fiberglass / glass mineral fiber segmented board pipe and tank insulation: Glass fibers bonded with a thermosetting resin, complying with ASTM C1393, Category 1. Semi-rigid, segmented board in roll form with glass fibers adhered perpendicular to the vapor retarder facing. Provide insulation with factory applied White ASJ+ vapor retarder facing complying with ASTM C1136, Type II, IV, X. Compressive strength per ASTM C165, not less than 120 psf at 10% deformation. Thermal conductivity (k-value) at 100 degrees F mean temperature shall be 0.26 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 850 degrees F. Provide Knauf Insulation Earthwool Pipe & Tank Insulation with ECOSE Technology or approved equal.

D. STEAM, AND STEAM CONDENSATE PIPING: Provide fiberglass/glass mineral fiber preformed pipe insulation in accordance with ASTM C547, Type I and IV; ASTM C585, ASTM C411, and ASTM C795 with ASJ+ SSL+ vapor retarder jacket complying with ASTM C1136. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.23 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 1,000 degrees F. Provide Knauf Insulation Earthwool 1000 Insulation with ECOSE Technology or approved equal.

E. CONDENSATE DRAINAGE PIPING: Provide flexible elastomeric cellular thermal insulation in accordance with ASTM C534/C534M. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.276 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 230 degrees F. Provide model "Armaflex Ultima", fire rated for use in environmental air plenums; insulation not required when piping is exposed on roof.

F. REFRIGERANT PIPING: Provide flexible elastomeric cellular thermal insulation in accordance with ASTM C534/C534M. Provide model "Armaflex Ultima", fire rated for use in environmental air plenums for all indoor applications. Thermal conductivity (k-value) at 75 degrees F mean temperature shall be 0.276 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 230 degrees F. Provide model "AP Armaflex", with secured metal jacketing for all outdoor applications.

G. STAND-BY GENERATOR ENGINE EXHAUST PIPING: For interior generator installation applications, the entire engine exhaust pipe including exhaust muffler from exhaust manifold to outside terminal shall be enclosed in two layers of a 1" thick calcium silicate insulation to protect maintenance personnel from hot surfaces per NFPA 37 as well as to limit heat transmission to the space. Joints for the first and second layer shall be staggered. Provide calcium silicate granular thermal insulation in accordance with ASTM C533, Type I with secured metal jacketing. Calcium silicate insulation shall be rated as noncombustible when tested in accordance with ASTM E136. Thermal conductivity (k-value) at 500 degrees F mean temperature shall be 0.54 Btu x in. /h x sq. ft. x degrees F, or less as tested in accordance with ASTM C533. Maximum service temperature of 1,200 degrees F. Provide Johns Manville Thermo-1200 or approved equal.

H. FACTORY-APPLIED VAPOR RETARDERS - ALL SERVICE JACKETING (ASJ+): Vapor retarder jacket for interior applications shall be composed of an aluminum foil layer, reinforced with glass scrim, bonded to a layer of white kraft paper, interleaving with an outer polymer film leaving no paper exposed; complying with ASTM C1136.

I. FIELD-APPLIED PROTECTIVE FINISHES

1. METAL JACKETING: Provide aluminum jacketing complying with ASTM C1729 or stainless steel jacketing complying with ASTM C1767. Metal jacketing shall have a minimum thickness of 0.016 inches for piping sizes through 6” diameter, 0.020” for piping sizes 8” diameter through 10” diameter, and 0.024” for piping sizes 12” diameter through 24” diameter. Provide pre-formed fitting covers for all elbows and tees.

J. HIGH DENSITY INSERTS

1. Provide high density inserts at all pipe support locations as indicated herein to prevent excessive compression of the insulation. High density inserts shall have a minimum compressive strength of 100 psig. Pipe supports shall either be noncombustible, or be UL listed and labeled in accordance with UL 2043. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required. Refer to 23 05 29 - Hangers and Supports for Piping and Equipment - HVAC .

2. Provide 360° high density inserts at all pipe support locations for fiberglass insulation applications. High density inserts shall be calcium silicate for fiberglass insulation applications.

3. Provide 180° high density inserts at all pipe support locations for phenolic foam insulation applications for piping 4” diameter or larger. High density inserts shall be phenolic foam insulation meeting the compressive strength requirements indicated herein.

4. Provide 360° high density inserts at all pipe support locations for flexible elastomeric cellular thermal insulation applications. Provide ArmaFix EcoLight or equal.

2.4 INSULATING CEMENTS

A. Mineral Fiber Insulating Cement: Comply with ASTM C195.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic: Water based; suitable for indoor and outdoor use on below ambient services. Water-Vapor Permeance shall be 0.09 perms at 55-mils dry film thickness when tested in accordance with ASTM E96/E96M, Procedure A. Service Temperature Range shall be -20 to +180 degrees F. Solids content shall be 59 percent by volume and 71 percent by weight per ASTM D1644. Provide Childers CP-35 or approved equal.

2.6 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F. Provide Childers CP-97 or approved equal.

C. Fiberglass / Glass Mineral Fiber Adhesive: Comply with MIL-DTL-3316C, Class 2, Grade A. Provide Childers CP-82 or approved equal.

D. Flexible elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I. Provide Armacell Armaflex 520 BLV or approved equal.

2.7 LAGGING ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation. Service Temperature Range shall be 0 to +180 degrees F. Provide Childers CP-52 or approved equal.

2.8 SEALANTS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Metal Jacket Flashing Sealants shall be fire and water-resistant, flexible, elastomeric sealants with a service temperature range of -40 to +250 degrees F. Provide Childers CP-76 or approved equal.

C. Fire Barrier Sealant shall be a latex-based, intumescent sealant that dries to form a monolithic firestop seal. Fire barrier sealant shall be firestop tested up to 4 hours in accordance with ASTM E814 and fire resistance tested in accordance with ASTM E1966. Provide 3M CP 25WB+ or approved equal.

2.9 GLASS FIBER FABRIC REINFORCING MESH

A. Woven Glass Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch. Provide Childers Chil-Glas No. 10 or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. To ensure that external fiberglass/glass mineral fiber flexible blanket and rigid board insulation will achieve its highest possible performance and serve its intended purpose, install all mechanical insulation materials and associated accessories in accordance with manufacturer’s published instructions and industry practices detailed by the NACIIS Manual as published by the Midwest Insulation Contractors Association (MICA).

B. All insulation shall be installed in accordance with the manufacturer’s recommendations and printed installation instructions, including high density inserts at all hangers and pipe supports to prevent compression of insulation.

C. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer’s requirements.

D. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

E. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of pipe and fittings.

F. All heat recovery piping between air conditioning equipment and hydronic or domestic hot water piping shall be insulated per the High Temperature Surfaces Schedule below.

G. All condenser water piping located in a ceiling plenum shall be insulated per the requirements for indoor chilled water piping as indicated in the Low Temperature Surfaces Schedule below.

H. Pipes located outdoors, in crawlspaces, parking garages,or tunnels shall be insulated same as concealed piping and be provided with metal jacketing with longitudinal 1/2” safety hem and 2 inch overlap. Jacketing shall be easily removed and replaced without damage. Jacket securement shall be by metal banding with clips. Banding material shall match jacketing material. Galvanized steel banding is not acceptable.

I. Installation of flexible elastomeric foam insulation shall be in accordance with ASTM C1710.

J. Provide all HVAC piping insulation to comply with the ASHRAE Std 90.1 I-P Minimum Thickness Schedule and as indicated below.

1. Minimum Insulation Thickness for Low Temperature Surfaces

a. Condensate drain lines: 1 inch

b. Chilled Water Piping

1) Located outdoors: 2 inch

2) Located indoors:

(a) 4 inch and smaller: 1-½ inch

(b) Larger than 4 inch: 2 inch

c. Refrigerant Piping

1) 1½“ and smaller: 1 inch

2) Larger than 1½ inch: 1-½ inch

2. Minimum Insulation Thickness for High Temperature Surfaces

a. Heating Water Piping

1) Operating temperature 105°F or less: 1 inch

2) Operating temperature higher than 105°F and pipe size 1-¼ inch or smaller: 1-½ inch

3) Operating temperature higher than 105°F and pipe size greater than 1-¼ inch: 2 inch

b. Low Pressure Steam Piping: operating temperature less than 250°F

1) Pipe size 3 inch and smaller: 2-½ inch

2) Pipe size greater than 3 inch: 3 inch

c. Medium Pressure Steam Piping: operating temperatures between 250°F and 349°F

1) Pipe size 1 inch and smaller: 4 inch

2) Pipe size greater than 1 inch: 4-½ inch

d. High Pressure Steam Piping: operating temperature 350°F and greater: 5 inch

e. Refrigerant Piping

1) 1-½ inch and smaller: 1-½ inch

2) Larger than 1-½ inch: 2 inch

3.2 WATER PIPE INSULATION INSTALLATION

A. The insulation shall be applied to clean, dry pipes with all joints firmly butted together. Where piping is interrupted by fittings, flanges, valves or hangers and at intervals not to exceed 12 feet on straight runs, a vapor dam shall be formed between the vapor retarder jacket and the bare pipe. The seal shall be by the applications of vapor retarder mastic to the exposed insulation joint faces, carried continuously down to and along 4 inches of pipe and up to and along 2 inches of jacket.

B. Pipe fittings and valves shall be insulated with pre-molded or shop fabricated fiberglass / glass mineral fiber covers finished with two brush coats of vapor retarder mastic reinforced with glass fabric.

C. All under lap surfaces shall be clean and free of dust, etc. before the joint is sealed. These laps shall be firmly rubbed to insure a positive seal. A brush coat of vapor retarder mastic shall be applied to all edges of the vapor retarder jacket.

D. At hangers and supports, provide a high-density insulation insert that extends 2" beyond the insulation shield on each side and a protective shield/saddle to prevent excessive compression/damage. Secure shield/saddle to insulation using mastic. Refer to 23 05 29 - Hangers and Supports for Piping and Equipment - HVAC.

3.3 FIRE RATED ASSEMBLY PENETRATIONS

A. All pipe penetrations through walls and concrete floors shall be fire rated by applying rock mineral fiber insulation in the annular space between the pipe and its associated sleeve.

B. Seal penetrations through fire rated assemblies with an approved fire barrier sealant. Refer to Division 7 for further requirements regarding “"Through-Penetration Firestop Systems”.

C. All fire stopping material shall be installed in accordance with manufacturer's printed instructions.

END OF SECTION

SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract Documents, including General and Supplementary Conditions and Division 01 Specifications, apply to this section.

1.2 RELATED SECTIONS:

A. Section 01 91 00 - General Commissioning Requirements

B. Section 23 09 63 - Energy Management and Control System (EMCS)

1.3 SUMMARY

A. The commissioning of the HVAC system and associated controls shall be performed by an impartial technical firm hired by the owner. The commissioning provider shall be certified under one or more of the following certifications:

1. CxA - Certified Commissioning Authority - ACG
2. CBCP - Certified Building Commissioning Professional - AEE
3. CCP - Certified Commissioning Professional - BCA
4. CPMP - Certified Process Management Professional - ASHRAE
5. BSC - Building System Commissioning Certification - NEBB

B. The commissioning provider (Commissioning authority) shall be responsible for leading the entire construction team through the commissioning process including, but not limited to, conducting the commissioning kick-off meeting, preparing the commissioning plan, preparing pre-functional checklists, preparing functional test scripts, participation in functional testing and preparation of required documentation and reports.

1.4 RESPONSIBILITIES

A. Contractor: Responsibilities of the Contractor as related to the Commissioning Process include, but are not limited to the following:

1. Facilitate coordination of Commissioning work by Commissioning authority.
2. Attend Commissioning meetings or other meetings called by Commissioning authority to facilitate the Commissioning Process.
3. Review Functional Performance Test procedures for feasibility, safety, and impact on warranty, and provide Commissioning authority with written comment on same.
4. Provide all documentation relating to manufacturer’s recommended performance testing of equipment and systems.

5. Provide Operations & Maintenance data to Commissioning authority for preparation of checklists and training manuals.

6. Provide Testing and Balancing Report before Functional Testing begins.

7. Provide As-built drawings and documentation to facilitate Testing.

8. Assure and facilitate participation and cooperation of Sub Contractors and equipment suppliers as required for the Commissioning Process.

9. Certify to Commissioning authority that installation work listed in Pre-Functional Checklists has been completed.

10. Install systems and equipment in strict conformance with project specifications, manufacturer's recommended installation procedures, and Pre-Functional Checklists.

11. Provide data concerning performance, installation, and start-up of systems.

12. Provide copy of manufacturers filled-out start-up forms for equipment and systems.

13. Ensure systems have been started and fully checked for proper operation prior to arranging for Testing with Commissioning authority. Prepare and submit to Commissioning authority **written** certification that each piece of equipment and/or system has been started according to manufacturer's recommended procedure, and that system has been tested for compliance with operational requirements.

    a. Contractor shall carry out manufacturer's recommended start-up and testing procedures, regardless of whether or not they are specifically listed in Pre-Functional Checklists.

    b. Contractor is not relieved of obligation for systems/equipment demonstration where performance testing is required by specifications, but a Functional Performance Test is not specifically designated by Commissioning authority.

14. Coordinate with Commissioning authority to determine mutually acceptable date of Functional Performance Tests.

15. Provide qualified personnel to assist and participate in Commissioning.

16. Provide test instruments and communications devices, as prescribed by Commissioning authority, required for carrying out Testing of systems.

17. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Test Engineer in the commissioning process. Proprietary test equipment shall become the property of the Owner upon completion of commissioning.

18. Ensure deficiencies found in the Commissioning Issues Log are corrected within the time schedule shown in the Commissioning Plan.

19. Provide Commissioning authority with all submittals, start-up instructions manuals, operating parameters, and other pertinent information related to Commissioning Process. This information shall be routed through Architect.

20. Provide commissioning authority with a certificate of readiness to show systems are ready to schedule functional testing.

21. Prepare and submit to Commissioning authority proposed Training Program outline for each system.

22. Coordinate and provide training of Owner's personnel.

23. Prepare Operation & Maintenance Manuals and As-Built drawings in accordance with specifications; submit copy to Commissioning authority in addition to other contractually required submissions. Revise and resubmit manuals in accordance with Design Professionals and Commissioning authority comments.

24. Commissioning requires participation of this Division Subcontractors to ensure that systems are operating in manner consistent with Contract Documents. All costs associated with the participation of Contractor, Sub-Contractors, Design Professionals, and Equipment Vendors in the Commissioning Process shall be included as part of the Construction Contract.

B. Subcontractors and vendors shall prepare and submit to Commissioning authority proposed Startup procedures to demonstrate proper installation of systems, according to these specifications and checklists prepared by Commissioning authority

1.5 COMMISSIONING PLAN

A. Commissioning Process tasks and activities:

1. Commissioning kick-off meeting: Conducted by commissioning authority and attended by construction team and design team.

2. Pre-functional checklists: Prepared by the commissioning authority and filled out by subcontractors performing the work that is applicable.

3. Site visits to review installation of applicable systems and progress of checklist documentation performed and reported by commissioning authority.

4. Functional testing: Commissioning authority shall conduct functional testing with assistance of applicable subcontractors and document successful results as well as deficiencies (issues). Functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing in accordance with plans and specifications. Testing shall include all modes and sequence of operation, including under full-load, part-load and emergency conditions (including all alarms). Controls system shall be tested to document that control devices, components, equipment and systems are calibrated and adjusted and operate in accordance with the plans and specifications. Sequences shall be functionally tested to document they operate in accordance with plans and specifications.

5. Preliminary commissioning report: Commissioning authority shall issue a preliminary commissioning report to the owner that has results of the first round of functional testing including deficiencies discovered.

6. Air and hydronic system balancing: Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the contract documents. System balancing shall be performed by TAB contractor as specified in 23 05 93 - Testing, Adjusting, And Balancing.

7. Systems manual: Commissioning authority shall compile the systems manual using submittal data provided by the general contractor and applicable subcontractors.

8. Final commissioning report: Commissioning authority shall issue final commissioning report documenting the entire process and final results of functional testing. Report shall include final testing and balancing report.

B. Equipment to be tested

1. Energy Management and Control System:

   a. Graphical User Interface

   b. Automation Software

   c. Field Level Controllers

   d. Field Level Devices

   e. Control Sequences

2. Chilled Water Systems (All chillers and pumps)

3. Condenser Water Systems (All towers and pumps)

4. Heating Water Systems (All boilers and pumps)

5. Air Handling Systems (All AHU and 10% of terminal units)

6. Energy Recovery Systems (100%)

7. Water Treatment Systems (Verify vendors completion of scope)

8. Service water heating systems (100%)

C. Testing functions and conditions

1. Energy conservation programs (economizer, optimal start, etc)

2. Verify shutdown of systems when scheduled.

3. Calibration of sensors

4. Testing shall affirm winter and summer design conditions.

5. Test under full outside air conditions.

6. Confirm functionality of all specified sequences of operations.

7. Verify the functionality of all alarms.

D. Performance criteria

1. Air and water temperatures shall be within tolerances specified in the contract documents.

2. Space temperatures shall be maintained within 1 degree of specified set points.

3. Space humidity shall be maintained within 5% of specified levels.

PART 2 - PRODUCTS

2.1 NO PRODUCTS SUPPLIED

PART 3 - EXECUTION

3.1 GENERAL

A. This Division has startup responsibilities and are required to complete sub-systems so COMPLETE SYSTEMS are fully functional. Insuring they meet design requirements of Contract Documents. Commissioning procedures and testing do not relieve or lessen this responsibility or shift this responsibility, in whole or in part, to Commissioning Agent or Owner.

B. Coordinate with other Sub-Contractors and equipment vendors to set aside adequate time to address Pre-Functional Checklists, Functional Performance Tests, Operations & Maintenance Manual creation, Owner Training, and associated coordination meetings.

C. Commissioning authority will also conduct site inspections at critical times and issue Cx Field Reports with observations on installation deficiencies so that they may be issued by Architect as deemed appropriate.

3.2 WORK PRIOR TO COMMISSIONING

A. Complete all phases of the work so the systems can be started, adjusted, balanced, tested, and otherwise tested.

B. See pertinent specification sections in this Division, which outline responsibilities for start-up of equipment with obligations to complete systems, including all sub-systems so that they are fully functional.

C. Assist commissioning authority with all information pertaining to actual equipment and installation as required complete the full commissioning scope.

D. Contractor shall prepare startup procedures to demonstrate compliance with pre-functional checklists, and coordinate scheduling for completion of these checklists.

E. A minimum of 7 days prior to date of system startup, submit to Commissioning authority for review, detailed description of equipment start-up procedures which contractor proposes to perform to demonstrate conformance of systems to specifications and Checklists.

3.3 PARTICIPATION IN COMMISSIONING

A. Attend meetings related to the Commissioning Process; arrange for attendance by personnel and vendors directly involved in the project, prior to testing of their systems.

B. Provide skilled technicians to startup and test all systems, and place systems in complete and fully functioning service in accordance with Contract Documents.

C. Provide skilled technicians, experienced and familiar with systems being commissioned, to assist Commissioning authority in commissioning process.

3.4 WORK TO RESOLVE DEFICIENCIES

A. Complete corrective work in a timely manner to allow expeditious completion of Commissioning Process. If deadlines pass without resolution of identified problems, Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs thus incurred will be Contractor’s responsibility.

3.5 PRE-FUNCTIONAL CHECKLISTS (PFC)

A. Contractor shall complete Pre-Functional Checklists to validate compliance with Contract Documents installation and start-up requirements, for this Division’s systems.

B. Refer to commissioning plan for detailed list of equipment to be commissioned.

3.6 FUNCTIONAL PERFORMANCE TESTING (FPT)

A. Contractor, in cooperation with Commissioning Agent, shall conduct Functional Performance Testing to validate compliance with Contract Documents.

B. Provide commissioning authority with a certificate of readiness to show systems are ready to schedule functional testing.

C. Refer to commissioning plan for detailed list of equipment to be commissioned.

D. Assist Commissioning authority in Functional Testing by removing equipment covers, opening access panels, etc. Furnish ladders, flashlights, meters, gauges, or other inspection equipment as necessary.

E. DBR has included a small contingency for limited retesting, however DBR reserves the right to stop testing on a system when the system:

1. Does not have the correct graphics programmed.

2. Does not have the correct data trends programmed.

3. Does not have the correct set points programmed.

4. Does not have the equipment or system safeties installed and programmed correctly.

5. The TAB data forms have not been submitted to our firm or the performance of the system listed on the TAB forms is not per project requirements.

6. Line items of the functional performance test have failed.

F. Sampling

1. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy.

2. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in pre-functional checklist execution.

3. A common sampling strategy is the “xx% Sampling - yy% Failure Rule”, defined by the following example.

a. xx = the percent of the group of identical equipment to be included in each sample.

b. yy = the percent of the sample that if failing, will require another sample to be tested.

c. The example below describes a 20% Sampling - 10% Failure Rule.

d. Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample.”

e. If 10% (yy) of the units in the first sample fail the functional tests, test another 20% of the group (the second sample).

f. If 10% of the units in the second sample fail, test all remaining units in the whole group.

g. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

G. Re-Testing And Failure To Remedy Deficiencies

1. Despite Contractor’s best efforts to ensure systems are problem-free, it is expected that some deficiencies will be found during initial inspection of Pre-functional Checklist, and during initial Functional Testing; such deficiencies are expected to be minimal.

2. It is Contractor’s responsibility to remedy identified deficiencies, both in Pre-functional Checklist and in Functional Testing phases of work, in a timely and thorough manner.

3. It is Contractor's responsibility to ensure that all deficiencies are corrected prior to requesting a re-inspection or re-test of systems and equipment. Do not request re-inspection or re-test until deficiencies are corrected.

    a. At his discretion, CxA may agree to re-testing systems or equipment where deficiencies remain which are beyond Contractor's control to resolve expeditiously.

    b. Typically such re-testing of incomplete systems and equipment will take place only if remaining deficiencies are minor in scope and nature, and are of such nature that they cannot be resolved in a timely manner (such as those due to difficulties in obtaining parts, or where Owner has requested a change that has delayed work, etc.)

4. CxA will carry out a second re-inspection or re-test of systems and equipment subsequent to receiving Contractor's request.

    a. If CxA finds deficiencies identified in initial inspection or test have not been remedied (with exception of un-resolvable deficiencies in 3.b. above), and such remaining deficiencies are significant enough to require additional inspection or re-testing, Contractor will be back-charged for CxA's expenses, and time at a rate of $150.00 per hour and $100.00 expenses, for a third and any subsequent re-inspections and re-tests.

H. Deferred Testing

1. "Seasonal Commissioning" pertains to testing during peak heating or cooling seasons when HVAC equipment is operating at full-load or heavy-load conditions. Initial commissioning will be done as soon as contract work is completed, regardless of season. Seasonal Commissioning under full- or heavy-load conditions other than the current season will be handled at later time by GC and CxA.

2. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods.

3. GC is to provide services of personnel and participate in seasonal testing process in the same manner as he would in non-seasonal testing.

4. Until off-season commissioning can be accomplished, Owner may retain an amount from GC's payment sufficient to cover the cost of off-season testing.

5. Unforeseen Deferred Tests: If any check or test cannot be completed due to building structure, required occupancy condition, or other reason, execution of checklists and functional testing may be delayed upon approval of Owner. Tests shall be conducted in same manner as seasonal tests, as soon as possible. Services of required parties will be negotiated. Make final adjustments to Operation and Maintenance Manuals and record drawings due to unforeseen deferred tests.

6. GC is to provide services of personnel and participate in deferred testing in the same manner as he would for normal commissioning.

3.7 TRAINING

A. The following requirements are in addition to Operations & Maintenance requirements specified elsewhere in this specifications manual.

B. Contractor shall be responsible for training coordination and scheduling, and ultimately to ensure that training is completed.

C. The training agenda (plan) shall include, at a minimum, the following elements:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

D. Commissioning authority shall be responsible for overseeing and approving content and adequacy of training of Owner personnel for all installed systems. Provide Commissioning authority with training plan two weeks before planned training.

3.8 OPERATIONS & MAINTENANCE MANUALS

A. The following requirements are in addition to Operations & Maintenance requirements specified elsewhere in this specifications manual.

B. Sub-Contractor shall compile and prepare documentation for equipment and systems specified in this Division, and shall deliver documentation to Contractor for inclusion in Operation & Maintenance Manuals, in accordance with requirements of Division 01, prior to training Owner personnel.

C. Provide Commissioning authority with a single, electronic copy of Operation & Maintenance Manuals for review. Commissioning authority copy of O&M manuals shall be submitted through Architect.

D. Operation and maintenance manuals shall include, service agency contact information, maintenance requirements, controls system settings and a narrative of how each system is intended to operate, including set points.

3.9 DOCUMENTATION

A. Commissioning authority shall provide documentation of process as follows:

1. Preliminary commissioning report including test procedures, results of testing, itemization of deficiencies, deferred tests and climatic conditions required for performance of deferred tests. Preliminary commissioning report shall be issued to owner to demonstrate the first pass of testing has occurred and to demonstrate compliance with applicable codes.

2. Final commissioning report shall include the final test and balance report, final results of functional testing, disposition of deficiencies discovered during testing, including the details of corrective measures used and functional testing procedures used for repeatability of testing in the future.

END OF SECTION

SECTION 23 09 53 - REFRIGERANT MONITOR SYSTEM

PART 1 - GENERAL

1.1 GENERAL

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 WORK INCLUDED

A. Refrigerant monitoring system and all related controls and accessories.

1.3 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 09 63 - Energy Management and Control System (EMCS)

C. Section 23 64 16 - Centrifugal Water Chillers

D. Section 23 64 26 - Rotary Screw Water Chillers

1.4 REFERENCES

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

B. ICC (IFC) - International Fire Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 QUALITY ASSURANCE

A. Refrigerant monitoring system shall be configured to meet ASHRAE Std 15, B-52 and all ICC (IMC) International Mechanical Code and ICC (IFC) International Fire Code requirements.

B. All monitoring system wiring shall be in accordance with NFPA 70.

C. Installation and Start-up: Provide services of a representative authorized by the manufacturer to perform inspection, start-up and certification of system.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division One.

1.7 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment

2. Principle of how the equipment works

3. Important parts and assemblies

4. How the equipment achieves its purpose and necessary operating conditions

5. Most likely failure modes, causes and corrections

6. On site demonstration

PART 2 - PRODUCTS

2.1 GENERAL

A. The gas monitoring system shall continuously measure and display the specified gas concentration. The system shall provide visual indicators when preset limits are exceeded. Relay output for alarms and control shall be provided.

B. Gases detected and the detection range shall be as follows:

Gas	Range/Full Scale
R-123	0 - 1,000 ppm
R-1233zd	0 - 1,000 ppm
R-134a	0 - 1,000 ppm
R-513A	0 - 1,000 ppm
R-515B	0 - 1,000 ppm

2.2 SYSTEM CONFIGURATION

A. Description - The system may consist of one of the following configurations:

1. Base remote sensor module including the Photoacoustic IR (PAIR) sensor, power supply.

2. Split construction with a control module and remote sensing module.

3. Stand-alone type with integrated control and sensing modules in a single enclosure.

B. Sensor Module - The unit shall be a wall mount type. It shall conform to Paragraphs 1 through 9.

1. NEMA 4X enclosure

2. Photoacoustic IR Sensor.

3. Five LED status indicators.

4. 24 VAC or VDC operation or 110/220, 50/60 Hz options.

5. Optional beacon

6. 4-20 mA and RS-485 ModBus outputs.

7. Single channel diffusion or optional pump sampling.

8. 4-channel sequencer with sample solenoids can be added as an option but requires the use of the Control Module to drive the sequencer.

9. 20 PPM detection limit.

C. Control Module - The unit shall be a wall mount type. It shall conform to Paragraphs 1 through 9.

1. Enclosure Type - The enclosure shall be a NEMA 4X version.

2. The control module shall feature digital signal processing with RS-232 system compatible. A 4-20 mA output and 0-10VDC shall also be available.

3. Accepts up to 8 remote sensor inputs over a single pair cable or up to 2 remote sensors with 4-channel pump/sequencer or any combination up to 8 channels.

4. Digital Display with optional remote display.

5. Three levels of Alarm and Fault indicators.

6. System configured via the front panel keypad.

7. Provides 24VDC power to operate remote sensors.

8. An 85 Db audible alarm with an acknowledge switch shall be available as standard on the control module.

9. A visual alarm strobe shall be available as an option on all units. System power shall be 110/220 VAC 50/60 Hz.

D. Stand - Alone, Integrated Unit - The unit shall be wall mount type. It shall conform to Paragraphs 1 through 9.

1. Photoacoustic IR sensor

2. Diffusion operation or pumped with up to 4 sampling points.

3. 20 PPM detection limit

4. Digital signal processing

5. Digital display with optional remote display

6. 4-20 mA, 0-10VDC and RS-232 Outputs standard.

7. Three levels of Alarm and Fault status indicators.

8. System configured via the front panel keypad.

9. Enclosure Type - The enclosure shall be a NEMA 4X version.

E. Operating Principle - The principle of operation shall be of the infrared photo acoustic absorption type.

1. Analyzer Sample - Any version of the analyzer may be configured as a diffusion type monitor or be equipped with an internal pump and filter that can draw a sample from a distance of 300 feet. All sample connections shall be on the bottom of the enclosure.

2. Analyzer Sensitivity - The analyzer limit of detection for all refrigerants shall be 20 PPM.

3. Analyzer Linearity - The analyzer shall be within +/-5 PPM of a linear response in the range of 0-100 ppm and + 5% of full scale in the range of 100-1000 ppm.

4. Temperature - The system shall operate over the range of 0o to 45o C.

5. Stability - The 24 hour zero or span drift must be less than 5 PPM. The long term (1year) zero drift shall be less than 5 PPM. The long term span drift shall be less 10 PPM.

F. Calibration: The calibration of all versions shall be performed using standard RP cylinders and existing calibration equipment.

2.3 MONITOR UNIT REQUIREMENTS:

A. Readout Displays - A 2 line x 20 character alpha numeric display shall be provided for the purpose of displaying the gas concentration, diagnostics, set-up and calibration menu.

B. Visual Alarm Indicators - All alarm indications shall be displayed on the front panel display.

C. Alarm Set Point Levels - Three separate alarm set point levels shall be provided. The set points shall be independently adjustable for any value for a given range. The set points shall provide drive signals to user interface relays. The alarm set points shall have the capability of providing the user a selection of latching or non--latching.

D. Relay outputs - The alarm set point drive signals shall activate user relays as specified in Paragraphs 1 through 4.

1. Number of Relays - As a minimum, one relay for each alarm set point level shall be provided on the control unit.

2. Contact Rating - All relays shall be Form C, single pole, double throw. Dry contacts shall be rated for 5 amps resistive at 240 VAC.

3. Contact Selection - The contacts shall be capable of being selected normally energized or non-energized, latching or non-latching.

4. The Trouble (Fault) relay is normally energized and closed for normal conditions. If a system fault is detected the Trouble relay will de-energize.

E. Malfunction Indication - The readout display described in Paragraph 1.5.1 shall display full diagnostics when a fault exists without the use of codes.

F. Audible Alarm - An audible buzzer is included; it sounds when one of the three pre-selected alarm conditions or a trouble condition occurs.

G. Front Panel Controls - The function listed in this paragraph shall be accomplished using a keypad readily accessible on the front panel.

1. No tool or special adapters shall be used for:

a. Display of alarm set point level on the readout display.

b. Resetting any alarm set point

c. Zero and Span calibration adjustment

H. Sample Gas Filter - There shall be an internal sample gas filter on pumped units. This filter shall be easily serviced or replaced.

I. Output Signals

1. The 4-20 mA output shall have the following features:

a. Scalable to 1-10% of the full scale. The default shall be 100% full scale.

b. The output shall be sourcing current to module ground.

c. For refrigerants, software will have a dead-banding feature not allowing a value less than 10 PPM to be displayed on the front panel.

2. RS-485 using ModBus communication protocol will be included in all sensor modules.

3. The control modules will have an ATO output option of RS-232, 4-20mA, or 0-10VDC.

4. The 10 volt analog output may be used to identify the station being monitored in a multipoint sequencing unit.

J. System Power Requirements shall be standard at 24 VDC or VAC. Optional input voltages shall be available for either module at 110 or 220 VAC, 50/60 Hz.

K. Multi Point Capability - The system shall be expandable to include a Multi-Point Sequencer with up to four (4) sampling points. Use of the sequencer requires the Control Module for control.

L. System must be capable of allowing the user, through the front panel keypad, to determine which of the four (4) points are to be active in the sequencer.

M. A method of detecting a flow blockage shall be provided.

N. Sequencer Programming Limits - The sequencer system parameters shall be within the following limits.

O. Sample Tubing Connection - Fittings suitable for the connection of 1/4" O.D. tubing shall be provided on the bottom of the enclosure for the purposes of connection, sample lines, calibration gases and exhaust.

P. Alarm - Three alarm set point levels shall be provided for each sample location. Any alarm set point shall be capable of activating one relay (SPDT, 8 amp at120 VAC, resistive).

Q. Indicating Lights - All indications related to the Multi Point Sequencer shall appear on the front panel display.

R. Software shall be installed in the pumped versions to allow the user to enter the station dwell time to allow for the line length and sample transport time for each sensor.

2.4 SAMPLE HANDLING

A. Sample Line Compatibility - The system shall be capable of drawing a sample through 1/8" I.D. tubing for a distance of 300 feet.

B. Sequencer Operation - A sample shall be drawn from the next line in sequence regardless of which location is being analyzed.

C. Sample Conditioning - The system shall provide adequate filtration of the sample suitable to protect the analyzer.

D. Exhaust - Exhaust fitting shall be provided on the bottom of the enclosure for the purpose of attaching lines to the exhaust and bypass flows.

2.5 SYSTEM MAINTENANCE REQUIREMENTS

A. Maximum System Maintenance Requirements - The system shall require no periodic maintenance other than periodic checking. Periodic checking or adjustments of the unit shall be capable of being accomplished by one person at the unit location.

B. Manufacturer Capability Requirements - As a minimum, the Gas Monitoring Equipment manufacturer must meet the following requirements:

1. Be capable of supplying all equipment used to check or calibrate the unit

2. Be capable of providing onsite service with factory trained personnel

3. Be capable of providing start-up assistance and training for the owner / operator

2.6 EMERGENCY SIGNS

A. Emergency signs shall be provided in accordance with NFPA 704. Signs shall include a warning that the visual and audible alarms indicate a refrigerant leak has been detected and the monitored area should be evacuated. Sign material shall be engraved, laminated, UV resistant plastic or etched metal with self-adhesive backing. Submittals shall include sign material, dimensions, color, lettering format, and warning message for approval.

2.7 ACCEPTABLE MANUFACTURERS

A. Mine Safety Appliances Company Chillgard 5000

B. Honeywell Analytics model 301EM-20

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.

B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.

C. The Gas Monitoring System shall be tested, approved, and certified for electrical safety.

D. Emergency signs shall be installed outside each exit door to monitored rooms. Install signs near alarms located at exits where they can be easily seen. Coordinate final locations with the Architect and Owner prior to installation.

3.2 SPARE PARTS

A. Provide at least 1 spare device for each type of gas detection sensor specified herein.

3.3 COMMISSIONING

A. After installation, test equipment to demonstrate operation of functions as described in the sequence of operations.

B. Manufacturer shall include services for the commissioning of the system.

C. After installation, provide test gas and required accessories to calibrate and verify proper operation, according to sequence of operation.

D. Provide testing kits, including gas bottles, for testing and calibration.

E. Provide demonstration and training for operations personnel.

F. Provide a system manual with operation and testing instructions. System manual shall include test forms and documentation of the initial calibration, testing and certification. System manual shall be submitted with O&M manual and distributed to operational personnel at time of training.

END OF SECTION

SECTION 23 09 63 - ENERGY MANAGEMENT AND CONTROL SYSTEM (EMCS)

PART 1 - GENERAL

1.1 GENERAL

A. The Energy Management and Control System (EMCS) shall be comprised of a Local Area Network (LAN) infrastructure, Operator Workstations (OWS), Engineering Workstations (EWS), a Primary Network Server (PNS), Network Area Controllers (NAC), Application Specific Controllers (ASC), Unitary System Controllers (USC), and Field Devices installed within the facility. The EMCS Contractor shall provide a completely wired system. Wireless components and wireless communication are not acceptable.

B. The Workstations, Primary Network Server, and Network Area Controllers shall be connected by a EMCS Contractor supplied and installed Local Area Network. The LAN shall comply with all IEEE Standards as outlined in the latest revision of IEEE 802: Local and Metropolitan Networks: Overview and Architecture.

C. The EMCS communication network shall include a dedicated, home-run Category 6 communication cable from the EMCS network backbone to all central plant control panels, including but not limited to chillers, boilers, cooling towers, pumping systems, chiller room refrigerant monitoring, boiler room carbon monoxide monitoring, and associated systems. To ensure that any communication failure occurring outside the central plant does not interrupt EMCS communication with central plant equipment, this cable shall not be routed through intermediate control panels, communication trunks, or field device daisy chains serving other areas of the building.

D. Outside of the central plant, the EMCS contractor shall segment the remainder of the EMCS communication network into a minimum of four (4) independent sectors, each served by separate trunks, to allow isolation of communication failures and simplify troubleshooting. Building segmentation layout shall be coordinated with the Owner and Engineer prior to installation.

E. If the EMCS contractor wishes to connect to the Owner’s Wide Area/Local Area Network as part of the control system network, the EMCS contractor shall acquire permission in writing and include the letter in the submittal. Any system that requires connection to the owner’s network for communication between NAC, ASC, USC and/or field devices that is submitted without the written permission from the owner shall be rejected. The EMCS Contractor shall coordinate with the Owner and supply all required information.

F. Access to the system, either locally in the building, or remotely from a central site or sites, shall be accomplished through standard web browsers, via the Internet and/or a local area network.

G. All EMCS controllers and workstations shall communicate using the protocols and network standards as defined by ASHRAE Std 135, latest revision. Management level TCP/IP Ethernet network speeds shall be 1 Gbps minimum and the Automation Level MS/TP network speeds shall be 76.8 Kbps minimum.

H. The Server shall gather data from the system and generate HTML pages accessible through a conventional web browser from all personal computers (PCs) connected to the network. System shall include any and all software and hardware to support at least 50 simultaneous users. The EMCS shall be compatible with all common web browsers.

I. Facility Operators shall be able to view and configure systems through the standard web browser and all graphical/data representations shall appear identical, whether the user is on site or viewing via the Internet at a remote location. Standard operator functions such as control point manipulation, configuration and viewing of trends, schedules and alarms shall be performed through the standard browser. Each mechanical system and building floor plan shall be depicted on the operator workstation by point-and-click graphics.

J. The EMCS shall directly control HVAC equipment as specified in the Sequence of Operations. Furnish Energy Conservation features such as Optimal Start/Stop, Night Setback, Setpoint Reset logic, and Demand Control Ventilation.

K. The EMCS vendor shall provide the following additional services as part of this specification: warranty and service during the warranty period; submittals, samples and record documentation; comprehensive startup and testing of the EMCS with documentation; training services for the owner and facility operators; coordination with other contractors and suppliers; operator and technician training program, and shall cooperate fully with the Project Commissioning Agent.

L. Products furnished under this specification but installed by others.

1. Mechanical devices installed under Division 23 by the mechanical contractor or other suppliers:

    a. Temperature sensing thermowells.

    b. Automatic control valves and actuators.

    c. Pipe taps for flowmeters.

    d. Water pressure sensors and switches.

    e. Automatic control dampers and actuators not installed in air handling unit mixing boxes or louvers.

    f. Damper actuators for automatic control dampers installed in air handling unit mixing boxes.

    g. Damper actuators for variable air volume (VAV) terminal units.

    h. Mounting cost of controller and actuator for variable air volume (VAV) terminal units.

2. Electrical devices installed under Division 26 by the electrical contractor:

    a. 120 VAC power to controllers and control panels at locations indicated on the drawings. Review and verify that these locations are adequate for the proposed EMCS.

b. Interlock wiring to duct mounted smoke detector or fire alarm shutdown relays to HVAC equipment motor starters and variable frequency drives (VFD).

M. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

1.2 RELATED DOCUMENTS & REFERENCES

A. Drawings and general provisions of the contract documents, apply to this section including:

1. Division 01 for General Conditions and Supplementary Conditions.

2. Division 21 for fire protection equipment.

3. Division 22 for plumbing equipment and domestic water systems.

4. Division 23 for mechanical equipment, ductwork, and piping systems.

5. Division 26 for electrical equipment, lighting control, and fire alarm systems.

B. The latest edition of the following standards and codes in effect as approved by the authority having jurisdiction and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. ANSI MC85.1 - Terminology for Automatic Control.

2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

3. ASHRAE Std 135 - BACnet.

4. BTL Mark by the BACnet Testing Laboratories.

5. Uniform Building Code (UBC), including local amendments.

6. UL 916 - Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.

7. NFPA 70, National Electrical Code (NEC).

8. FCC Part 15, Subpart J, Class A.

9. National Institute of Standards and Technology (NIST).

10. IEEE 802: Local and Metropolitan Networks: Overview and Architecture.

1.3 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 00 and Division 01 for allowances and related contractual requirements.

B. Refer to Division 21 for General Fire Protection Provisions and fire suppression pump.

1. The EMCS contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP is acceptable if IP interface is not available from equipment manufacturer.

2. The EMCS contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.

C. Refer to Division 22 for General Plumbing Provisions, domestic water heating systems, domestic water pumping systems, domestic water metering, and natural gas metering.

1. The EMCS contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP is acceptable if IP interface is not available from equipment manufacturer.

2. The EMCS contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.

D. Refer to Division 23 for General Mechanical Provisions for equipment such as chillers, cooling towers, boilers, pumps, air-handling units, terminal units, ventilation fans, variable frequency drives, unitary AC units, etc.

1. The EMCS contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP is acceptable if IP interface is not available from equipment manufacturer.

2. The EMCS contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.

E. Refer to Division 26 for General Electrical Provisions for equipment such as electrical switchgear control, electrical power monitoring, emergency generators, lighting control system, etc.

1. The EMCS contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP is acceptable if IP interface is not available from equipment manufacturer.

2. The EMCS contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.

1.4 ELECTRICAL POWER PROVISIONS

A. Primary power will be provided under Division 26 by the electrical contractor to the panel locations indicated on the mechanical & electrical drawings. Provide step down transformers within panel enclosures. Provide all necessary fuses and circuit protection devices.

B. Power will be provided to the controllers serving fan powered terminal units with electric heat via the control transformer provided with the unit.

C. All components of the EMCS shall be powered from the sources above. Provide final terminations from the locations indicated on the Division 23 Drawings.

D. The EMCS Contractor shall provide any additional control power that is required as part of this contract and not indicated by other. This shall include all conduit, cabling, circuit breakers, etc.

E. Controllers must remain powered even if the equipment they control is disabled. If hardwired interlocks or relays could interrupt controller power, the controllers shall use an independent power circuit to ensure continuous reporting to the EMCS.

1.5 CONTRACTOR QUALIFICATIONS

A. The EMCS Contractor shall:

1. Have a local staff of trained personnel capable of giving instructions and providing routine and emergency maintenance on the EMCS, all components and software/firmware and all other elements of the EMCS.

2. Have a proven record of experience in the supply and installation of equivalent BACnet systems over a minimum period of five years. Provide documentation of at least three projects of equivalent scale and complexity, if so requested by the Owner’s Representative.

3. Be a factory certified representative of the native BACnet EMCS manufacturer for design, installation, and service of the proposed system.

4. Have comprehensive local service, training and support facilities for the total EMCS as provided. Maintain local, supplies of essential expendable parts.

1.6 SUBMITTALS

A. ALL DOCUMENTS SUBMITTED SHALL BE IN NATIVE PDF FORMAT. NO SCANS.

B. Shop Drawings:

1. The following information shall be included on the cover page for each shop drawing and equipment documentation submittal:

a. Project name with date. Refer to the applicable specifications by name and number.

b. Provide submittal number and re-submittal number and date as applicable.

c. Provided name and address of Consulting Engineer, Mechanical Contractor, General Contractor

2. Shop drawings shall be CAD generated, plot size of 8-1/2” x 11” or 11” x 17”. Drawings shall include diagrams, mounting instructions, installation procedures, equipment details and software descriptions for all aspects of the system to be installed.

3. Provide schematic of systems indicating instrumentation locations, all interconnecting cables between supplied cabinets on a mechanical floor plan.

4. Software specifications and descriptions including operating sequences.

5. Provide a bill of material that indicates specific manufacturer, part number, part description and quantity of each device for all system components.

6. Provide a list of the wire labels to be installed on each end of the control wiring, at the device and the control panel terminal. Labels shall be machine generated, typed and legible with a maximum of 17 characters. The label description “AHU-1 SAT” shall indicate the supply air temperature of AHU-1.

7. Equipment Schematic: Provide an electronic equipment schematic for each piece of mechanical equipment. The schematic shall display all mechanical equipment characteristics including fans, dampers, valves, sensors and other applicable control devices. The schematic shall show wiring terminations to each control device as shown in the submittal and as-build documentation. Control devices shall be labeled by a symbol that can easily be identified in a bill of material that is shown on this graphic. The bill of material shall show the device symbol, description, manufacturer and part number.

8. Sequence of Operations: The control sequences shall be viewable for each piece of mechanical equipment and be in a text format as shown in the as built documentation. The sequence of operations shall be selectable at the applicable location for the control program.

C. Control component submittals:

1. Component technical data sheets with mounting and installation details.

2. The documentation shall include comprehensive and complete details of the BIBB and automation level documentation including address, associated controller type, etc. as required and for the interface to the EMCS.

3. Details of networks/communications equipment, cabling and protocols proposed. Provide schedule of cabling including details of proposed cable types.

4. Module Drawing: Provide an electronic wiring diagram of each control module (as shown in submittal documentation). Diagram shall display wiring schematic and terminations to end devices. Diagram shall display each input and output terminals and label those that are used for the control application. Diagram shall display module type/name and network address.

5. Field sensor and instrumentation specification sheets. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

6. Schedule and specification sheets for dampers, valves and actuators.

7. Design and provide layout of all components of panel mounted control devices, terminal strips and power supplies.

D. Colorgraphics: Provide sample layout of color graphic representations of the systems for review. The submittal shall indicate the quality of the graphic to be provided with the system with a sample of the specific control points to be included. Control points shall as a minimum include points indicated in the input/output summary, control schematic and primary controlling points defined in the sequences of operation. Provide a sample of a floor plan layout, typical AHU, terminal unit, outside air pretreatment unit, variable frequency drive, exhaust/supply fan, chiller plant and hot water plant. For control points to be provided by equipment BACnet integration provide sample of the control points, up to 25 total.

E. Verification Reports: The submittal shall include a sample of the verification reports to be utilized during the verification section of this specification. Sample reports shall be approved as submitted or be modified by the engineer or owner's representative. The verification reports shall be included in the final Operation & Maintenance Manuals. Reports shall be provided in electronic PDF format.

1. Project Systems Verification Form for each controller.

   a. General information for each form shall include: project name; associated equipment with mark number; control panel number and location; controller number and model number; controller device instance number (address); MS/TP LAN segment number; verifying technician and date.

   b. Each connected control point and device shall contain the following columns with a separate line for each connected physical point: point description (same as device label); input/output number for each connected control device (AI-XX, AO-XX, DI-XX, or DO-XX).

   c. Check boxes confirming that the verification tasks have been completed: device location, proper termination at device; proper termination at control panel; sequence is verified; point trend is enabled.

   d. Data entry boxes indicating measured/confirmed values: preliminary control point value on the graphic; observed control point value; calibration or adjustment value to correct offset; final displayed point value on the color-graphic; date of verification; engineer or owner's representative verification.

2. Control Panel Verification Form for each control panel.

a. General information: panel location and identification number; panel dimensions and NEMA rating; panel properly installed; Class 1 and Class 2 wiring are properly separated; correct voltage to the panel; no shorts or grounds in panel; no induce voltages in panel wiring; point to point termination match submittal; devices are mounted in the correct location; controller software revision number; address of controllers; panel device checkout is complete; panel startup is complete.

3. Sequence of Operation Verification Form per piece of equipment (AHU, VAV, chiller, boiler, etc.).

a. General information: project name; system identifier; building area served; control panel and controller numbers; controller model number and instance number (address); MS/TP LAN segment number; name of verifying technician and date.

b. Each step of the sequence of operation for each piece of equipment shall be documented shall include a “description of test”, “input to trigger test” and “expected outcome”. A pass/fail checkbox shall indicate each of these actions. Provide space for technician approval with associated date.

F. Operating and Maintenance (O&M) manuals: Provide O&M manual with full information to allow the owner to operate, maintain and repair installed products. Include trade names with model numbers, color, dimensions and other physical characteristics.

1. Format: Produce on 8-1/2 x 11-inch pages, and bind in 3-ring/binders with durable plastic covers. Label binder covers with printed title “OPERATION AND MAINTENANCE MANUAL”, title of project, and subject matter and “Number _ of _” of binder. Provide substantial dividers tabbed and titled by section/component number.

2. Table of Contents for each volume:

a. Part 1: Directory with name, address and telephone number of Designer, Contractor and Subcontractors and Suppliers for each Project Manual section.

b. Part 2: Operation and maintenance instructions, arranged by Project Manual Section number where practical and where not, by system. Include:

3. Product design criteria, functions, normal operating characteristic and limiting conditions. Installation, alignment, adjustment, checking instructions and troubleshooting guide. Operating instructions for start-up, normal operation, regulation and control, normal shutdown and emergency shutdown. Test data and performance curves.

4. Spare parts list for operating products, prepared by manufacturers including detailed drawings giving location of each maintainable part, lists of spares recommended for user- service inventory and nearest source of in-stock spares.

G. Record Documentation:

1. Details of all alarm, diagnostic, error and other messages. Detail the Operator action to be taken for each instance.

2. Detail special programs provided and provide a complete programming instruction manual. Detail operation of all software applications.

3. Detailed list of the database for all installed devices.

4. Record drawings shall be CAD generated and shall include final locations and point ID for each monitored and controlled device.

5. In additional to the required hard-copies, provide a CD-ROM with all of the record documentation in PDF format and a CD-ROM containing backup copies of all installed software and graphics.

6. Online as-built documentation: provide digital replications of as-builts that shall be accessible from each equipment graphic controlled or monitored by the EMCS.

1.7 WARRANTY

A. Warranty work and the equipment provided under this contract shall be for a period of one year from the date of Substantial Completion. Warranty shall cover all components, system software, parts and assemblies supplied by this contractor and shall be guaranteed against defects in materials and workmanship for one (1) year from the date of Substantial Completion. Labor to troubleshoot, repair, reprogram or replace system components that have failed due to defects in materials and workmanship shall be provided by this contractor at no charge to the owner during the warranty period. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks. All warranty work shall be performed by the EMCS contractor's local service group.

B. Warranty shall not include routine maintenance, e.g., equipment cleaning, mechanical parts lubrication, pilot lamp replacement, operational testing, etc. Warranty shall not cover repair or replacement of equipment damaged by under- or over-voltage, misuse, lack of proper maintenance, lightning, water damage from weather or piping failure.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the EMCS contractor. The maximum acceptable response time to provide this service at the site shall be 24 hours, during normal working hours.

1.8 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions

5. Most likely failure modes, causes and corrections.

6. On site demonstration that includes hands-on demonstration of the manipulation of setpoints, schedules and other adjustable elements of the system.

7. The demonstration shall be on the actual, completed graphic interface pages for the specific project.

B. Provide a second training session 3 months after initial session for any follow-up or additional training requested by owner's personnel. Allow 3 hours for the second training session.

1.9 OPERATOR WORKSTATION (OWS)

A. The Operator Workstation shall be any personal computer, connected to the LAN, with appropriate web browser software installed.

1.10 ENGINEERING WORKSTATION (EWS)

A. The Engineering Workstation shall be any personal computer, connected to the LAN, with a registered copy of the EMCS contractor supplied engineering and/or programming software installed. The EMCS contractor shall provide at least one copy of all required software(s), to enable the Owner complete editing/programming functions of all controllers, graphics, and control logic.

B. The EMCS shall provide one personal computer (PC) which is compatible with the performance required by the EMCS Engineering Software if an engineering workstation is specified for the system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE EMCS VENDORS

A. AUTOMATED LOGIC - Branch Office

B. RELIABLE CONTROLS - Unify Energy Solutions - Enviromatic

2.2 PRIMARY NETWORK SERVER (PNS)

A. The EMCS Contractor shall provide and install the Primary Network Server as part of this system. The PNS shall utilize the Internet and provide efficient integration of standard open protocols. The PNS shall maintain comprehensive database management, alarm management and messaging services, and graphical user interface as follows:

1. Support an unlimited number of users over the Internet/intranet with a standard web browser to access alarms, trend logs, graphics, schedules and configuration data. Access to the PNS shall be password protected utilizing authentication and encryption techniques. An audit trail of database changes indicating user, time stamp, and audit action shall be provided.

2. Enterprise level information exchange using an SQL database and HTTP/HTML/XML text formats.

3. Synchronize controller databases, database storage scheduling, control and energy management routines

4. Alarm processing and routing which includes email, SMS text messages and paging.

5. HTML based help system that includes comprehensive online system documentation.

6. Support of multiple Network Area Controllers (NAC) connected to a Local Area Network.

B. Server Functions

1. It shall be possible to access all Network Area Controllers (NAC) via a single connection to the server through the Ethernet LAN. In this configuration, each Network Area Controller can be accessed from a single user login.

2. The PNS shall provide the following functions, at a minimum:

a. The server shall provide complete access to distributed global data. The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.

b. The server shall include a master clock service for its subsystems and provide time synchronization for all NACs.

c. The server shall provide scheduling for all NACs and their underlying field control devices.

d. The server shall provide demand limiting control that operates across all NACs. The network server shall be capable of multiple demand limiting programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.

e. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to NACs. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.

f. The server shall provide central alarm management for all NACs supported by the server. Alarm management shall include: routing of alarms to a video display, a printer, an email and pager; view and acknowledge alarms; query alarm logs based on user-defined parameters

g. The server shall provide central management of logged data for all NACs supported by the server. Logged data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include: viewing and printing log data; exporting log data to other software applications; query log data based on user-defined parameters

3. The Primary Network Server shall be capable of supporting the following open system drivers;

a. BACnet/IP

b. Modbus TCP

C. Network Server Platform Requirements

1. Rack-Mounted Server Computer Hardware: DELL PowerEdge R220 or equal, Intel Xeon Gold 3.0 GHz or higher, 32GB RAM, 2 TB hard drive, video card, 22” color monitor, and Ethernet adapter 1Gbps or higher.

2. Operating system software shall be Microsoft Windows® 10 Professional or higher.

2.3 NETWORK AREA CONTROLLER (NAC)

A. Provide one or more Network Area Controllers (NAC) to meet the sequence of operations and the type and quantity of devices being integrated into the system. The NAC shall provide the interface between the local area network and the field controllers. The NAC shall provide global supervisory control functions over the associated controllers and shall be capable of executing application control programs to provide: calendar functions; scheduling; trending; alarm monitoring and routing; time synchronization; integration of controller data for each applicable protocol; network management functions for all network devices. The user may view real-time information via web-based data.

B. The Network Area Controller shall provide the following hardware features as a minimum: Ethernet Ports 100Mbps or higher, BACnet MS/TP ports, battery backup, DDR RAM memory, flash memory for long term data backup.

C. Provide an uninterruptible power source (UPS) per network controller to maintain operation for 1 hours.

D. The NAC shall be capable of operation over a temperature range of 32 to 122 °F and operation over a humidity range of 5 to 95% RH, non-condensing; storage temperatures of between 32 and 158 °F.

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

F. The NAC shall be capable of supporting the following open system drivers;

1. BACnet/IP

2. BACnet MS/TP

3. Modbus TCP

4. Modbus RTU

G. Event Alarm Notification and actions: The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers. Alarm conditions shall be routed to any defined user location whether connected to a local or wide-area network.

1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to: alarm; return to normal; fault.

2. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc. Allow timed routing of alarms by class, object, group, or node.

3. Provide alarm generation from binary object “runtime” and/or event counts for equipment maintenance (i.e. filter status, fan run status). Authorized users shall be able to reset runtime or event count values with appropriate password control.

4. Control equipment and network failures shall be treated as alarms and annunciated.

5. Alarms shall be annunciated in any of the following manners as defined by the user: screen message text; e-mail of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on: day of the week, time of day and recipient.

6. Color-graphic shall have flashing alarm object(s). Printed message may be routed directly to a dedicated alarm printer.

7. The following shall be recorded by the NAC for each alarm (at a minimum): time and date; location (building, floor, zone, office number, etc.); associated equipment. Upon acknowledgement of the alarm the NAC shall document the time, date and authorized user. The number of alarm occurrences since the last acknowledgement shall be recorded.

8. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user. Alarm actions may be initiated by user defined programmable objects created for that purpose.

9. Alarm archiving: A log of all alarms shall be maintained by the NAC and/or a server and shall be available for review by the user. Provide a “query” feature to allow review of specific alarms by user defined parameters. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

H. Data Collection and Storage: The NAC shall have the ability to collect data for any property of any object and store this data for future use.

1. The user shall designate the log as an interval log or deviation log. For an interval log, the object shall be configured for time of day, day of week and the sample collection interval. For deviation log, 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. 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. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

2. All log data shall be stored in a relational database in the NAC and the data shall be accessed from the server or a standard web browser. All log data, when accessed from the server, shall be capable of being manipulated using standard SQL statements.

3. All log data shall be available to the user in the following data formats: HTML, XML, plain text, comma separated values, as a minimum.

4. The NAC shall have the ability to archive its log data either locally or remotely to the server or other NAC on the network.

I. Local Access: The NAC shall provide redundancy of system access to the local controllers at the remote building if the Primary Network Server should lose communication or be off-line. The NAC shall maintain setpoint and scheduling features, access to the color-graphic displays, maintain trend logs and reports. Upon restoration of communication with the PNS the archived information shall be transmitted to the server for archiving.

2.4 SOFTWARE FOR THE NAC

A. The distributed architecture of the operating system for the PNS and NACs shall provide the operator a comprehensive interface to allow the operator to configure and customize the EMCS to optimize the HVAC system to save energy, schedule and maintain equipment and provide occupant comfort. The provided graphical toolset shall allow the operator to create applications in a drag and drop environment.

1. Input/output capability shall allow the operator to request the current value or status of the control point; command/override equipment to a specific state; add, change or delete control points, alarm limits and controllers; change descriptors to control points and equipment; modify parameters; create or modify DDC loops.

B. Operator System Access: Via software password with five access levels at workstations and at each control unit.

C. Color graphic tools shall allow the user to create equipment and floor plan graphics from a standard library of symbols; allow custom generation of symbols; utilize over 64 or more colors; create real-time dynamic data for the graphics. Up to 60 control points may be displayed on each graphic.

1. Provide a link between compatible graphics to minimize the paths to additional information. For example, provide the link from the zone sensor to the VAV terminal to the air handling unit and to the central plant. Web pages shall be provided to allow the operator to zoom into specific areas of the facility and then link the space to the floor plan to the overall building and then to the facility site plan.

2. Graphical tools shall allow the creation of bar graphs, pie graphs and other tools to visualize control information such as run time hours, energy consumed and occupant comfort.

D. Alarm processing tools shall allow the operator to create alarm messages that include as a minimum: time of alarm, point descriptor, alarm condition and remote annunciation. Critical alarms shall be displayed, archived to a storage device or printed on a alarm printer. Alarms shall be displayed in order of occurrence and have an optional audible alarm indicator.

1. Print alarm messages, up to 60 characters in length, for each alarm point specified.

2. Alarms may be routed to other devices including web-enabled cell phones, pagers, tablet PCs and designated personal computers on the network or Internet.

3. Operator specifies when alarm requires acknowledgment. Continue to indicate unacknowledged alarms after return to normal. An alarm log shall be maintained to archive alarms for future reference with the above specified parameters as well as indicating the person acknowledging the alarm.

4. The graphical display shall indicate the number of the current unacknowledged alarms by individual building site or by sum of all campus-wide facilities.

5. The operator may create and forward an e-mail message to another user directly from the graphical interface so that the message can be read when the second user logs on to the system.

E. Upon a power failure to equipment in the facility, the EMCS shall automatically start equipment upon the restoration of power. Program a time delay between individual equipment restart on a schedule to minimize demand charges from the utility company.

F. Custom reports may be created by the operator with a requested time and date manually or automatically. All reports may be logged to a storage device for future reference. The data reports shall allow customization and scaling of the X-Y coordinates; plotting of tabular reports; provide multi-point graphical reports with not less than eight variables on the same report. Print reports on daily, weekly, monthly, yearly or scheduled basis as scheduled.

G. The network server current operating system, database, color-graphics, custom reports shall be backed up automatically to a remote server or storage device as directed by the owner’s representative.

H. Maintenance Management capability shall allow the system to monitor and log the run-time for HVAC equipment; schedule maintenance reports that include recommended material and labor for the assigned task.

2.5 APPLICATION SPECIFIC CONTROLLERS (ASC)

A. All devices required for single loop control shall be terminated on a single controller. (for example, CHW loop pressure control. The differential pressure sensor and the pump VFD ramp signal.)

B. ASCs shall be capable of implementing control strategies for the system based on information from any or all connected inputs. The AC shall utilize factory pre-programmed global strategies that may be modified by field personnel on-site. Global control algorithms and automated control functions should execute via a 32-bit processor

C. Programming shall be object-oriented using control program blocks that will support a minimum of 500 Analog Values and 500 Binary Values. Analog and binary values shall support standard BACnet priority arrays. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing.

D. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1 year (cumulative). Battery shall be a field-replaceable (non-rechargeable) lithium type. The onboard, battery-backed real time clock must support schedule operations and trend logs.

E. The base unit of the ASC shall host various I/O combinations including universal inputs, binary outputs, and switch selectable analog outputs (0-10V or 0-20 mA). Inputs shall support thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.

F. All binary outputs shall have onboard Hand-Off-Auto switches and a status indicator light. HOA switch position shall be monitored. The position of each HOA switch shall be available system wide as a BACnet object.

G. Controller shall be capable of BACnet communication. BACnet Conformance:

1. Standard BACnet object types supported shall include as a minimum: Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event Enrollment, Notification Class, Program and Schedule object types. All necessary tools shall be supplied for working with proprietary information.

H. Schedules: Each ASC shall support a minimum of 10 BACnet schedule objects.

I. Logging Capabilities: Each controller shall support a minimum of 100 trend logs. Sample time interval shall be adjustable at the operator’s workstation. Controller shall periodically upload trended data to system server for long term archiving if desired. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

J. Alarm Generation: Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures. Alarm logs shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications. Controller must be able to handle up to 200 alarm setups stored as BACnet event enrollment objects -system destination and actions individually configurable.

2.6 UNITARY SYSTEM CONTROLLERS (USC)

A. All devices required for single loop control shall be terminated on a single controller. (for example, cooling coil control valve control. The temperature sensor and the valve control signal.)

B. The EMCS Contractor shall provide all Unitary System Controllers. USCs shall be fully programmable or applications specific controllers with pre-packaged operating sequences maintained in Flash RAM.

C. The USC shall be a node on the automation network and shall control its own communications so that the failure of any one node, shall not inhibit communications on the network between the remaining nodes. USCs shall be totally independent of other network nodes for their monitoring and control functions.

D. Provide each USC with a battery back-up for the protection of volatile memory for a minimum of 72 hours. Batteries shall be rated for a seven-year life.

E. All associated applications programs shall reside at the USC. The USC shall not require communication to any other panel for normal operating sequences other than time scheduled base commands.

F. Control shall be based on algorithms, i.e. proportional plus integral plus derivative (PID), proportional plus integral (PI), or proportional to comply with the sequences of operation PID algorithms shall maintain the system operation within +/- 2% of setpoint.

G. The USC shall be configured with sufficient input/output capacity to achieve the required control points to meet the sequence of operations.

2.7 VAV TERMINAL UNIT CONTROLLER (TUC)

A. All devices required for single loop control shall be terminated on a single controller. (for example, terminal unit air valve control. The flow sensor and the actuator control signal.)

B. The EMCS Contractor shall provide all controllers required for all variable air volume (VAV) terminal units. The number and location of terminal units and airflow rates shall be as indicated on the mechanical drawings.

C. The TUC shall be capable of monitoring and controlling the following parameters for VAV terminal units per the sequences of operation and input/output summary: space temperature; primary air flow rate; damper modulation; heating coil stage control, heating valve control, heating SCR control (as applicable); fan on/off control; supply air sensor; occupancy senor; carbon dioxide sensor or humidity sensor.

D. Furnish primary damper actuators, for factory mounting, meeting the following requirements: direct shaft mounting; adequate torque, to properly operate the damper from fully open to fully closed without binding; locking “V” groove or similar means to prevent slippage between actuator and shaft.

E. The EMCS Contractor shall field install the following components for each terminal unit: space temperature sensor; supply air temperature sensor; occupancy sensor, and carbon dioxide sensor as indicated on the Mechanical Drawings.

F. The EMCS Contractor shall furnish to the terminal unit manufacturer the following components for factory installation and wiring for each terminal unit: VAV controller with integral differential pressure transducer and damper actuator.

G. The terminal unit manufacturer may provide the following components for each terminal unit for interface and mounting of the TUC: primary air dampers; enclosure to house the TUC and associated components including suitable mounting brackets shall be NEMA 1 rating and located outside the terminal unit; multi-point averaging type flow sensor at the primary air inlet to the terminal unit; 24 VAC control transformer; 24 VAC fan control relay interface; 24 VAC heater control relay interface (up to two stages); 24 volt SCR heater input as scheduled (0-10 Vdc or 4-20 mA).

H. Any items required for proper operation but not provided by TU vendor, shall be provided under this section.

2.8 AIR HANDLING UNIT CONTROLLER

A. All devices required for single loop control shall be terminated on a single controller. (for example, AHU static pressure control. The differential pressure sensor and the VFD ramp signal.)

B. The EMCS Contractor shall provide controllers required for chilled/hot water and DX/electric heat air handling units and fan coil units. Provide an enclosure to house the controller and associated components including suitable mounting brackets shall be NEMA 1 rated and located outside the FCUs.

C. The controller shall be capable of monitoring and controlling the following parameters per the sequences of operation and input/output summary; space temperature; space relative humidity sensor; cooling/heating stage control or modulating valve control; fan on/off control and status; supply air sensor; occupancy sensor; carbon dioxide sensor; VFD control and monitoring.

2.9 EMCS CONTROLLER LEVEL NETWORK

A. EMCS Automation Level Network shall consist of BACnet MS/TP (76.8 Kbps minimum). Data transfer rate and data throughput as required to meet the alarm annunciation requirements.

2.10 SOFTWARE OVERVIEW

A. Dynamic Colored Floor plans: Dynamic colored floor plans that compare actual space conditions to setpoints shall be provided on all floorplan graphics displayed on the front-end. Floorplan enlargements shall also use the thermographs to display space conditions. Zones within the set point range shall appear transparent white. As the space gets warmer the zone color shall gradually modulate from transparent white to transparent red to identify a hot zone. As the space conditions get cooler the zone color shall gradually modulate from transparent white to transparent blue to identify a cold zone. Each zone shall indicate the current actual zone temperature within the zone. The floor plans shall use a dynamic scheduling icon to indicate schedule occupancy for each zone and provide direct one-click access to that zones unique schedule. Provide a designated icon or symbol indicating that the zone is in the occupied/unoccupied condition. From the floorplan graphic, the operator shall be able to click on any zone and go directly to the graphic for the piece of equipment controlling that zone. All dynamic floor plans shall be visible via web interface as well as on the LAN. The authorized system operator shall be able to change the zone or system identifier (or name) on the graphic and that change shall be distributed to other associated graphics and to the equipment controller.

B. Pop up Trends: Provide trend logs that automatically pop up when the operator mouse clicks on the point from the graphic. Provide pop up trends for all dampers, control valves, temperature sensors, carbon dioxide sensors, humidity sensors, airflows, static pressures, flow meters, VFD speeds, etc. The EMCS contractor shall set up all trends for the owner. The pop-up trend shall include a trend tool that allows the operator to modify the trend time scale and sample interval for up to 10 sample values. The trends shall be graphical on the computer screen but shall provide an output as an .xls, .csv, .pdf, HTML, or text file.

C. Interactive Maps: Implement JAVA SCRIPT API 3.0 or newer, such as Google Interactive maps depicting the facility location to indicate the site plan. This is not a static image and must be completely interactive.

D. Custom User HTML applications: The EMCS shall utilize HTML applications as an extra feature. At minimum, provide 7-day forecast, weather radar, traffic map and hurricane tracker. All of these features shall be imbedded into the EMCS system.

E. Provided a web-based EMCS platform; contractor shall provide an Open License software. Licenses that are not open are not acceptable. There shall be no per seat or per user licensing fee charged to the owner by the contractor.

F. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. Schedules, setpoints, trends, and alarms shall be BACnet Objects.

G. User access shall include 50 assigned operators that shall include five levels of access within the web system. Each operator log-in shall have an expiration date to allow for temporary access to the system. The operator’s access description shall include his e-mail address and cell/phone numbers. The operator access can be limited from 5 minutes to permanent access. The user shall be limited to eight bad login attempts before being locked out of the system.

H. Global modification: Provide the capability for global modification of user definable parameters of all points shall be provided. Global modification is defined as the mass adjustment of user definable parameters across a defined group, area, facility, campus, or network. Parameters shall include, but not be limited to temperature set point (VAV boxes, AHU Discharge, VAV AHU Static Pressure Setpoints etc.), equipment start/stop, equipment status, valve output signal, VFD speed control signal, and damper position signal. User shall be able to lock the definable parameter to a set value, or adjust a set point to an operator adjustable value. This function shall be accomplished through the standard graphical user interface/workstation and is to be selectively applicable by the user to all controllers on the network, all controllers in a specific facility or all controllers in a specific zone within a specific facility.

I. The system operator shall be able to override the output signal to the valves, dampers, variable frequency drives, etc. with the use of the PC mouse click on the device. The system override shall include a Hand-Off-Auto (HOA) capability. If the output is commanded to the hand position the operator shall designate an output value of 0-100% in 1% increments. The hand override position shall be permanent or expire after a designated time period and revert to the auto position. The color-graphic shall indicate the device that has been overridden by a color change of the output value.

J. For non-emergency in-warranty events the system operator may submit a Service Request directly from the floor plan or system graphic. The web interface shall include the EMCS suppliers contact information including phone numbers and e-mail address. The service request will be logged into the EMCS suppliers service department. A non-response by the assigned technician shall elevate the request to the next highest manager or supervisor until the system operator receives an response that their request has been received and is scheduled for a resolution. All requests for service shall be maintained in the customer’s database for future reference. The service request capability may be extended after the expiration of the warranty as part of a service agreement.

K. The web-based system shall be accessible from Tablet PCs and provide the same functionality that is available from personal computers connected through the LAN or WAN to the system operator. The tablet PCs as a minimum shall include an Apple iPad and Google Android based tablet PC. Operation shall include touch screen capability and use of the tablet keyboard screen. The operator shall be able to view color-graphics, system trends, override setpoints, change time schedules, and override damper and valve positions.

2.11 ENERGY SAVING PROGRAMS

A. Demand Limiting: Demand limiting programming and sequence shall include, but not be limited to the following:

1. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.

2. Integrate with lighting controls to reduce lighting power to an operator set maximum demand level.

3. Provide a means from the graphical user interface for the system operator to manually initiate or disable the demand limiting sequence.

4. Provide programming that will allow a demand response signal from an approved entity (electrical service provider) to remotely initiate or disable the demand limiting sequence.

5. Provide programming that will initiate demand limiting according to a schedule.

6. When demand limiting is initiated, the EMCS shall:

   a. Increase the space cooling temperature setpoint by 4 degrees F (adj), above the current operating setpoint. The rate of change for the temperature setpoint increase shall be operator adjustable.

   b. Decrease the space heating temperature setpoint by 4 degrees F (adj), below the current operating setpoint. The rate of change for the temperature setpoint decrease shall be operator adjustable.

   c. Automatically reduce lighting power on the circuits indicated on construction documents.

7. When demand limiting is disabled, the EMCS shall reset temperature setpoints and lighting power levels back to original operating setpoints.

8. Demand limiting shall be confined to “non-critical” zones. For purposes of planning, assume all zones are “non-critical” unless otherwise noted on the construction documents. All zones shall have the option to be added or removed from the demand limiting program, by the system operator.

9. The EMCS shall include a graphic "page" that shows all adjusted setpoints (original setpoints and demand limited setpoints) and the power meters being monitored to confirm the programming is operational and effective at shedding the associated loads.

B. Duty Cycling: Periodically stop and start loads, based on space temperature, and according to various on/off patterns.

C. Automatic Time Scheduling: Self-contained programs for automatic start/stop/scheduling of building loads. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary schedules.

D. Optimal Start/Stop: Perform optimized start/stop as function of outside conditions, inside conditions, or both. Optimization shall be adaptive and self-tuning, adjusting to changing conditions by modifying occupancy period based upon the desired temperature at beginning and end of the occupancy period. Base optimization on occupancy schedules, outside air temperature, seasonal requirements, and interior room temperature. Employ adaptive model prediction for how long building takes to warm up or cool down under different conditions.

E. Night-Setback Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours in conjunction with scheduled start/stop and optimum start/stop programs.

F. Setpoint Reset: Setpoints for control of variable load systems shall be reset based on load demand, as described in the Sequence of Operations.

G. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.

H. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.

I. Holiday Scheduling

J. Direct Digital Control: Furnish software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.

K. Trend logging shall be provided for all points per the input/output summary where there is a change in the analog or binary signal. Each controller shall be capable of storing trend values and then automatically transfer data to the NAC or the NS hard disk. Trend data shall be updated continuously per the operator assigned interval at intervals as low as one minute. Collect samples at intervals specified in minutes, hours, days, or month. Output trend logs as line-graphs or bar graphs. Binary points (input and output) shall only be logged upon a change of value (COV). Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

2.12 FIELD INSTRUMENTATION

A. Temperature Sensors: All temperature sensors shall be thermistor type, factory-calibrated to within 0.5 °F, interchangeable with housing appropriate for application. Sensors shall have a temperature curve rated for the application. Sensor wiring terminations shall be in a galvanized box.

1. Outside air temperature sensors shall be installed in weather proof enclosure with ventilated sun-shied.

2. Duct mounted temperature sensors shall be averaging type for supply air, mixed air and low temperature applications for air handling units. Duct probe temperature sensor shall be acceptable for terminal units.

3. Space temperature sensors shall contain a backlit LCD digital display and user function keys along with temperature sensor, setpoint adjustment and after-hours override use. Override time may be set in one-hour increments.

4. Thermowell temperature sensors shall be stainless steel probe of length that is equivalent to a minimum of 50% of the pipe diameter. End-to-end accuracy shall be ± 0.5 deg. F. Connection box shall be moisture/water proof with conduit fitting. Furnish the stainless steel thermowell to the mechanical contractor for installation. A thermal conducting grease shall be installed in the thermowell to provide uniform temperature sensing.

5. Provide flat plate stainless steel space temperature sensors with no local setpoint adjustment as indicated on the drawings.

B. Carbon Dioxide Sensors: The sensor shall be capable of monitoring carbon dioxide concentration with an accuracy of +/- 30 parts per million (PPM). The sensor shall produce a linear 0-10 VDC or 4-20 mA signal over the range of 0 to 2000 PPM. The sensor shall measure using non-dispersed infrared (NDIR) technology to measure carbon dioxide gas and shall be:

1. Wall mounted carbon dioxide sensors shall be Veris CWE series or equivalent.

2. Duct mounted carbon dioxide sensor shall be Veris CWD series or equivalent.

3. The EMCS contractor shall utilize the required calibration devices to properly commission and calibrate the sensors per the manufacturer's requirements.

C. Relative Humidity Sensors: relative humidity sensors shall be a two-wire type, 4-20 mA output proportional to the relative humidity range of 0-100%. The accuracy of the sensors shall be +/- 2% over a range of 10-90% RH.

1. Outdoor relative humidity sensors: provide non-corroding outdoor shield to minimize wind effects and solar heating. Install wall-mount weather proof enclosure with conduit fitting. Sensor shall be Veris HO series, or equivalent.

2. Wall-mounted relative humidity sensor: sensor shall be installed in a wall-mounted enclosure with white cover. Sensor shall be Veris HEW series or equivalent.

3. Duct-mounted relative humidity sensor: sensor shall be provided with a moisture resistant enclosure with conduit fitting. The probe length shall be 8" minimum. Sensor shall be Veris HED series or equivalent.

D. Pressure Transducers:

1. Air pressure transducer: The pressure transducer shall have an input range compatible with the medium being measured. The proportional output signal shall be 0-10 VDC or 4-20 mA. The accuracy shall be +/- 0.25% FS. Transducer shall be SETRA Model 264 or equivalent. Air pressure sensors and all associated tubing, hardware, and accessories shall be provided as appropriate for the application.

a. Duct mounted pressure sensor shall be stainless steel and provided with mounting flange and hardware. The sensor probe length shall be appropriate for the associated duct dimensions.

b. Wall mounted space pressure sensor shall include stainless steel wall plate, pressure pick up filter, and mounting hardware.

c. Ceiling mounted space pressure sensor shall be paintable, low-profile type, with pressure pick up filter, integral surge dampener, and adhesive ring for ceiling mount.

d. Outdoor pressure sensor shall include an outdoor rated sensor, 50 ft. of vinyl tubing, mounting bracket and hardware. A surge dampener shall also be provided for all outdoor pressure sensor applications to absorb pressure fluctuations.

2. Water pressure transducer: The pressure transducers shall have an input range compatible with the medium being measured. The proportional output signal shall be 0-10 VDC or 4-20 mA. The accuracy shall be +/- 0.25% FS. Transducer shall be SETRA Model 230 or equivalent. Transducer shall include a valved piping bypass and bleed off for each port. Water pressure sensors and all associated tubing, hardware, and accessories shall be provided as appropriate for the application.

E. Freezestat: Provide freezestats for all chilled water air handling systems that receive more than 10% untreated outside air. Freezestats shall provide vapor tension elements, which shall serpentine the inlet face on all coils. Provide additional sensors, wired in series, to provide one linear foot per square foot of coil surface area. Freezestat shall be manually reset at the switch. Interlock to the associated fan so that fan will shut down when HOA switch is in hand or auto position. Provide time delay relays with a 0-10 minute time delay relay duration to minimize nuisance freezestat trips. Time delay relay shall be adjustable at the associated control panel.

F. Air differential pressure switch: For fan shutdown, provide air differential pressure switches for all fans controlled by a variable frequency drive (VFD) to shut down the associated fan in the event of sensing high differential pressure. Air differential pressure switches shall have an adjustable setpoint with a range of 0-10 inches w.g. with manual reset at the switch unless otherwise indicated to be automatic reset or required by the application to be automatic reset. Provide ¼ inch copper tubing with compression fittings to mount to the side of the duct. Sensor shall be DWYER Series 1900 or equivalent.

G. Momentary control relays: Provide momentary control relays as indicated. Relays shall have coil ratings of 120 VAC, 50 mA or 10-30 VAC/VDC, 40 mA as suitable for the application. Contact ratings shall be 10 amp. Provide complete isolation between the control circuit and the digital output. Relays shall be located in the UC or other local enclosures and have pin-type terminals. Relays shall have LED indication of status.

H. Current sensing relay: Current sensing relays shall be rated for the applicable load. The output relay shall have an accessible trip adjustment over its complete operating range. Enclosure shall have an LED to indicate relay status.

I. Photocell: Ambient light level shall by a photocell in a non-corroding in a weatherproof housing with sun shield suitable for exterior installation. The control signal output shall be 4-20 ma or binary contact closure as specified in the sequences of operation. Mount the photocell on the north side of the building on the roof. The sensor reading shall be 0-750 foot-candles.

J. Occupancy Sensors

1. Occupancy sensors shall be dual-technology, ceiling mounted type. Sensors shall be capable of detecting presence in the control area by via Doppler shifts in transmitted ultrasound and passive infrared (PIR) heat changes. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off. The sensor shall operate at 24 VDC/VAC. WattStopper DT-300 or approved equal.

2. Sensors shall have a time delay that is adjustable with configuration software or shall have a fixed time delay of 5 to 30 minutes, set by a DIP switch. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

3. The sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options. The sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled.

2.13 HVAC VENTILATION SHUTDOWN SWITCH

A. The HVAC ventilation shutdown switch shall be a mushroom type switch, STI Series 2000 Stopper Station that complies with the following:

1. Color shall be coordinated with the Owner prior to ordering.

2. Latches when depressed.

3. Twist to reset.

4. Indoor/Outdoor flush type clear plastic cover.

5. Switch label shall read "HVAC VENTILATION SHUTDOWN" or other label approved by the Owner. Coordinate final label text with the Owner prior to ordering.

B. Coordinate final location of shutdown switch with the Mechanical Drawings, the Architect, and the Owner prior to installation.

2.14 WATER FLOW METERS

A. Insertion Electromagnetic Flow Meters shall be provided for HVAC metering and domestic water metering applications where indicated on mechanical drawings or in control diagrams in piping larger than 1 inch. The flow meter shall have a 316L stainless steel insertion probe with XAREC sensor head and weather-tight NEMA 4 electronics enclosure; +/- 1.0 % accuracy of actual reading from 2 to 20 ft/s and +/- 0.02 ft/s below 2 ft/s; flow range of 0.1 ft/s to 20 ft/s, turndown ratio of 200:1; pulse outputs proportional to flow rate. All wetted materials used in domestic water metering applications shall be NSF 61 and NSF 372 compliant. The flow meter shall be installed with a minimum of 10 diameters of straight pipe upstream and 5 diameters of straight pipe downstream. Refer to meter manufacturer's installation manual for additional straight pipe length requirements. Provide full port valve to allow for removal and re-insertion without disruption to the water service. Meters provided for HVAC applications shall be furnished and installed by Division 23. Meters provided for Domestic water applications shall be furnished by Division 23 and installed by Division 22. Meter shall be ONICON FT-3500 series or pre-approved substitution. Domestic water flow meters shall be approved by the associated Municipal Utility District (MUD).

B. Inline Wetted Ultrasonic Flow Meters shall be provided for cooling tower make-up water metering and blow down metering applications in piping ranging from ½" to 2 ½". The flow meter shall consist of a drop forged corrosion resistant metal flow body with process connections, integral transducers, transmitter with LCD display and user interface. All wetted materials shall be NSF 372 compliant; +/- 1.0 % accuracy of actual reading over a 25:1 turndown ratio; overall flow range turndown of 500:1; pulse and analog outputs proportional to flow rate and native BACnet MS/TP. Contractor shall provide a y-strainer upstream of each meter and isolation valves upstream and downstream of each meter. Placement of the flow meter must meet or exceed the manufacturer's published placement requirements. Meters shall be furnished and installed by Division 23. Meter shall be ONICON FT-4600 or pre-approved substitution. Cooling tower meters shall be approved by the associated Municipal Utility District (MUD).

2.15 WATER BTU METERING SYSTEMS

A. BTU metering systems shall be provided and calibrated by a single manufacturer and shall consist of a water flow meter, two temperature sensors, a BTU meter, temperature thermowells, and all other required installation hardware and accessories. All BTU metering system components shall be by ONICON or pre-approved substitution.

1. The BTU meter shall be a high accuracy, microprocessor-based instrument that includes integral backlit LCD display, front panel interface, calculator accuracy of +/- 0.05 %, and 24 VAC input power connection. The meter enclosure shall be NEMA 13 when installed indoors and NEMA 4 when installed outdoors. The BTU meter shall provide the following points both at the integral LCD and as outputs to the energy management and control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. All output signal data shall be communicated using BACnet® MS/TP or BACnet/IP. Each BTU meter shall be factory programmed for its specific application and shall be re-programmable using the front panel keypad without the use of any additional interface devices. BTU meter shall be ONICON SYSTEM-10 or pre-approved substitution.

2. Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within +/- 0.15˚F including the error from individual temperature sensors, sensor matching, input offsets, and calculations.

3. The flow meter shall be the type as specified in this section for the application. The flow meter shall be installed in either the supply or return pipe of the system to be measured and follow manufacturer's installation requirements as specified in this section.

2.16 NATURAL GAS FLOW METERS

A. Inline Thermal Mass Flow Meters shall be provided for natural gas sub-metering applications where indicated on mechanical drawings or in control diagrams in piping larger than 3/4". Natural gas flow meters shall be separate from the natural gas meter provided by the utility company. The flow meter shall have a 316L stainless steel insertion probe, built-in flow conditioner, flanged or NPT connections to match adjoining piping system, and weather-tight NEMA 4X electronics enclosure with interface and display; +/- 2.0 % accuracy of actual reading from 100 to 500 SFPM and +/- 1.0 % accuracy of actual reading from 500 to 7,000 SFPM; pulse and analog outputs proportional to flow rate and native BACnet MS/TP. The unit of measurement output from the meter shall be field selectable. The flow meter shall be installed with a minimum straight pipe run upstream and downstream of the flow meter as indicated in the manufacturer's installation manual. Refer to meter manufacturer's installation manual for additional requirements. Meters shall be furnished by Division 23 and installed by Division 22. Meter shall be ONICON F-5500 series or pre-approved substitution.

2.17 AIRFLOW MEASURING STATIONS (AFMS)

A. Duct mounted airflow measuring stations with combination airflow and air temperature measurement devices shall have the following features:

1. Multi-point sensors in one or more probe assemblies with a maximum of one to sixteen sensor nodes per location, and a single remotely mounted microprocessor-based transmitter for each measurement location. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Each sensing point shall independently determine the airflow rate and temperature at each node, which shall be equally weighted in calculations by the transmitter prior to output as the cross-sectional average. Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Each independent temperature sensor shall have a calibrated accuracy of +/-0.15° F (0.08° C) over the entire operating temperature range of -20° F to 160° F (-28.9° C to 71° C) and shall be calibrated at 3 temperatures against standards that are traceable to NIST. Acceptable manufacturer shall be EBTRON, Inc. GTx116-PC.

2. Each transmitter shall have a display capable of simultaneously displaying both airflow and temperature. Airflow rate shall be field configurable to be displayed as velocity or volumetric rates, selectable as IP or SI units. Each transmitter shall operate on 24 VAC and be fused and protected from over voltage, over current and power surges.

3. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of Reading over the entire calibrated airflow range of 0 to 5,000 fpm (25.4 m/s) and shall be wind tunnel calibrated at 16 points against air velocity standards that are traceable to NIST.

2.18 DAMPERS

A. Provide motorized volume control and shutoff dampers as detailed in 23 33 00 - Ductwork Accessories.

2.19 DAMPER ACTUATORS

A. Outside and exhaust air damper actuators shall be mechanical spring return. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.

B. Outside and return air modulating actuators shall utilize analog (proportional) control 0-10 VDC. Actuators shall be driven in both the open and closed directions.

C. Electric damper actuators shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.

D. Single section dampers shall have one electronic actuator direct shaft mounted.

E. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section.

F. Damper actuators shall be BELIMO or equivalent only if approved by district.

2.20 CONTROL VALVES

A. Furnish all valves controlled by the EMCS as shown on the Mechanical Drawings. Furnish all automated isolation valves as shown on the Mechanical Drawings. Control valves shall be factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. EMCS contractor to size control valve with a maximum of 3 psi pressure drop. 2-position isolation valves shall be full-line size.

1. All chilled water, condenser water, and hot water valves shall meet, at minimum, the following ANSI Class 150 ratings. Valves 0.5 inch to 2 inches shall have NPT female threaded ends. Valves 2.5 inches and larger shall have flanged ends.

2. Equal Percentage control characteristic shall be provided for all water coil control valves.

B. Pressure Independent Characterized Control Ball Valves ½" to 6", for two-way modulating applications shall have equal percentage characteristics and control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSI across the valve. The pressure independent control valve shall be provided and delivered from a single manufacturer as a complete assembly. The actuator shall be integrally mounted to the valve at the factory with a single screw on a direct coupled DIN mounting-base. All valve actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow and/or temperature control. Programming using actuator mounted switches or multi-turn actuators are not acceptable. The control valves shall be sized for the scheduled flow and not pressure drop. Calibrated Balancing Valves and Automatic Flow Limiting Valves shall be prohibited from use at coil circuit piping where pressure independent control valves are installed. Contractor shall provide a section of straight pipe five times the pipe diameter with respect to the nominal valve size upstream of the control valve assembly where utilizing integral flow sensor to guarantee sensor accuracy.

1. NPS 3/4" and Smaller: Belimo PIQCV or equal. Forged brass body rated at no less than 360 PSI, stainless steel ball and blowout-proof stem, characterizing disc integral to ball, PTFE ball seat, dual EPDM lubricated O-rings, and female NPT union ends. Close off pressure rating of 100 psi. Integral pressure regulator located upstream of ball to maintain a constant pressure differential. Replaceable cartridge type regulators are not permitted.

2. NPS 1" through 2": Belimo ePIV or equal. Forged brass, nickel-plated body rated at no less than 360 PSI, stainless steel ball and blowout-proof stem, PTFE ball seat, dual EPDM lubricated O-rings, stainless steel or TEFZEL characterizing disc, and female NPT union ends. Close off pressure rating of 200 psi. Valve shall be integrated with an electronic (ultra-sonic or electromagnetic) flow sensor (accuracy +/- 2%) providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential range of 1 to 50 psi.

3. NPS 2-1/2" through 6": Belimo ePIV or equal. GG25 cast iron body according to ANSI 125, Class B, stainless steel ball and blowout-proof stem, PTFE ball seat, with a dual EPDM lubricated O-rings and a stainless steel flow characterizing disc. End connection pattern to match ANSI 125 flange. Close off pressure rating of 100 psi. Valve shall be integrated with an electronic (ultra-sonic or electromagnetic) flow sensor (accuracy +/- 2%) providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential range of 1 to 50 psi.

C. Characterized Control Ball Valves (CCV) for ½' to 2": for 3-way modulating applications shall have equal percentage characteristics. Manufacturer shall be Belimo or approved equal. Balancing valves shall be provided in all coil circuits that utilize 3-way control valves.

1. Valve housing shall consist of forged brass rated at no less than 400 psi at 250 °F. Three-way valves shall have EPDM O-rings behind ball seals to allow for a minimum close-off pressure of 40 psi with an actuator that provides 35 in-lbs torque for ½ to 2 in. sizes. Three-way valves shall be installed in a "tee" configuration with actuator perpendicular to the shaft. Confirm mixing or diverting application for correct valve selection.

D. Globe Valves 2-1/2" to 6": for 3-way modulating applications shall have equal percentage characteristics. Manufacturer shall be Belimo G7 series or approved equal. Balancing valves shall be provided in all coil circuits that utilize 3-way control valves.

1. Valve housing shall consist of cast iron rated at no less than 125 psi at 300 °F. Valve shall have stainless steel stem, plug and seat. Three-way valves shall be installed in a "tee" configuration with actuator perpendicular to the shaft. Confirm mixing or diverting application for correct valve selection.

E. Butterfly valves: For chiller and cooling tower isolation control valves, butterfly control valves may be provided.

1. Butterfly Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats. Butterfly valves shall have ductile iron body, 304 stainless steel disc and EPDM seat. The valve body close-off pressure rating shall be 150 psi over a range of -20 °F to 250 °F. The flange shall be ANSI 125/250. Provide Belimo Series F6 and F7 or Bray Series 3L.

F. Actuators for characterized control valves and globe valves: Provide electric actuators for all control valves that are furnished as part of the EMCS contract. Two-way and three- way control valve actuators shall meet, at minimum, the following requirements:

1. Motor driven type with gear assembly made of hardened steel. Actuator shall have an input voltage of 24 VAC. Provide visual mechanical position indication.

2. Actuators installed within the interior of the building envelope shall be provided with NEMA-2 rated housings.

3. Actuators installed exterior to the building envelope shall be provided with NEMA-4 rated housings or a weather shield. All penetrations through exterior actuator housings shall be provided with fittings that prevent water ingress.

4. Valves shall be sized to meet the shut-off requirements when operating at the maximum system differential pressure and with the installed system pump operating at shut-off head. Actuators shall control against system maximum working pressures.

5. Normal and failure positions shall be as indicated in the operating sequences. Provide spring return action per the sequences.

6. Manual declutch lever to enable manual operation of the valve. It shall be possible for an operator to manually modulate valves located in mechanical rooms in the event of loss of power.

7. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for butterfly valve actuators.

8. All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.

9. Electric actuators shall be Belimo, compatible with the valves furnished.

G. Butterfly Valve Industrial Actuators

1. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.

2. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1 phase, 60 Hz supply. Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.

3. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.

4. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250 VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.

5. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.

6. The actuator shall be analog, floating, or two position as called out in the control sequence of operation. All analog valves shall be positive positioning, and respond to a 2-10 VDC, 4-20 mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.

7. Butterfly valve actuators shall be Belimo furnished with specified butterfly valves.

2.21 REFRIGERANT LEAK DETECTION

A. Refrigerant leak detection monitors shall be provided for the refrigerant and number of chillers installed.

1. Power consumption: AC - 325 mA, DC - 250 mA. Volt free contacts to indicate an alarm condition.

2. Operating temperature range of 32 °F to 105 °F. Operating humidity range of 0 to 95% non-condensing.

3. Measuring range of 0-1000 ppm proportional to 4 to 20mA output range for each sampling point.

4. System shall detect the presence of the types of refrigerants provided with the chillers using sequential sampling and multi-point monitoring method.

5. System shall annunciate to the EMCS through a contact closure and have a local alarm (audible and visual) Control panel shall have a silencing alarm button. Initial alarm shall comply with recommended Allowable Exposure Level (AEL). Adjustable 3 level alarm for each point shall be supplied with common alarm output contacts. Provide local digital indication of ppm level for a minimum of 1 sample point per chiller. A sample point shall be located close to each chiller and the refrigerant pump out unit location. Location to be approved by the engineer. Sample point if in alarm shall flash the associated LED. Provide local alarm horns and visual (stroboscopic) beacons at the following locations to activate upon alarm to an approved detail:

a. Outside of entrance doors to chiller machine room.

b. Inside rooms without an escape route other than through the chiller room.

c. At each chiller location.

d. At any other location in the chiller room as necessary to ensure that a person at any location in the chiller room and room that can be entered from the chiller room can see the visual alarm and hear the audible alarm and at any other location required to meet the applicable codes.

6. Emergency signs shall be provided in accordance with NFPA 704. Signs shall include a warning that the visual and audible alarms indicate a refrigerant leak has been detected and the monitored area should be evacuated. Sign material shall be engraved, laminated, UV resistant plastic or etched metal with self-adhesive backing. Submittals shall include sign material, dimensions, color, lettering format, and warning message for approval. Emergency signs shall be installed outside each exit door to monitored rooms. Install signs near alarms located at exits where they can be easily seen. Coordinate final locations with the Architect and Owner prior to installation.

7. System shall shut down all electrical equipment (chiller systems and associated pumps, AHU, FCU, etc.) and sequence emergency extract equipment as required to meet regulations. Where combustion equipment is employed, refrigerant vapor monitoring system shall automatically shut down the combustion process in event of refrigerant leakage if other alternative acceptable conditions are not applied. Ventilation system, chiller and associated pumps and other equipment shut down as a result of the refrigerant leak alarm shall return to normal operation when the refrigerant monitoring system is no longer detecting refrigerant levels above set points and alarms have been silenced.

8. System shall have self-diagnostics and supply common malfunction output. Loss of sample flow at either sample or ZERO line and electrical malfunction shall annunciate to the EMCS.

9. Provide two (2) additional particulate filters and zero gas filter cartridges.

10. Provide an emergency shut-off control button outside each chiller plant room entrance/exit door. Button shall be mounted at 48 inches above finished floor adjacent to refrigerant leak detection alarm light. Activation of any one of the buttons shall de-energize all chillers and other electrical equipment within the chiller plant room. Button shall be manually reset.

11. Provide BACnet MS/TP interface to EMCS. Provide Strobe/Horns and Emergency Push Buttons.

12. Maximum System Maintenance Requirements - The system shall require no periodic maintenance other than periodic checking. Periodic checking or adjustments of the unit shall be capable of being accomplished by one person at the unit location.

13. Manufacturer Capability Requirements - As a minimum, the Gas Monitoring Equipment manufacturer must meet the following requirements:

    a. Be capable of supplying all equipment used to check or calibrate the unit

    b. Be capable of providing onsite service with factory trained personnel

    c. Be capable of providing start-up assistance and training for the owner/operator

14. Gas Monitoring System shall be a Mine Safety Appliances Company Chillgard RT Refrigerant Monitor or equal.

2.22 PANELS AND ENCLOSURES

A. Provide panels and enclosures for all components of the EMCS, which are susceptible to physical or environmental damage.

B. Interior panels and enclosures shall meet be NEMA 1 rated painted steel panels with locking door.

C. Exterior mounted panels and enclosures shall be NEMA 4 painted steel panels with locking door.

D. Panels for USCs shall be mounted on the outside of all unit ventilators and fan coil units with three feet of wall clearance in front of them and no higher than 7 feet to the bottom of the panel.

2.23 LABELING AND WARNING NOTICES

A. Provide labeling for all control panels and enclosures.

B. Provide labeling of all control wires and input/output points at the controller and at the control device; the label at each end of the wire shall be the same Labels shall be machine generated, typed and clearly legible with a maximum of 17 characters. Hand written labels or labels written on the control wire jacket will not be acceptable. Each label shall be unique to its function and shall reference the applicable system. For example “AHU-1 SAT” will indicate the supply air temperature sensor for AHU-1. Improper labeling shall be removed and shall require re-commissioning of the control device and controller to document correct functionality.

C. Provide high voltage warning notices at all equipment controlled by the EMCS and at all associated motor starters when used by equipment controller.

2.24 TUBING AND PIPING

A. Provide tubing and piping as required for the field instrumentation.

B. Tubing within equipment rooms, vertical risers, and penetrations to ductwork shall be either copper pipe or shall be plastic tubing within conduit. Tubing for all water-based instrumentation shall be copper pipe. Identify the type of tubing proposed in the shop drawing submittal.

C. Provide suitable bulk head fittings for duct and panel penetrations.

D. Tubing in plenum rated areas may be plastic tubing. Polyethylene tubing shall meet, at minimum, the following requirements: flame retardant; crack resistant; 300 psi burst pressure.

2.25 CONDUIT AND FITTINGS

A. Provide all conduits, raceways and fittings for the EMCS monitoring, communication and control cabling. All work shall meet all applicable codes.

B. Conduit, where required, shall meet, the requirements specified within Division 26.

C. EMCS monitoring and control cable shall not share conduit with cable carrying voltages in excess of 90 VAC.

2.26 CABLING

A. Provide all cables for the EMCS. Cable shall meet, at minimum, the following requirements:

1. Minimum 98% conductivity stranded copper.

2. Proper impedance for the application as recommended by the EMCS component manufacturer.

3. Monitoring and control cable shall be #18 AWG or larger, dependent on the application. Analog input and output cabling shall be shielded.

4. Management Level Network cable shall be CAT 6, 24 gauge unshielded.

5. Automation Level Network cable shall be #24 AWG shielded.

6. Shield shall be grounded at the CCP, UC, or control panel. Ground at one end only to avoid ground loops.

7. Identification of each end at the termination point. Identification should be indicated on and correspond to the record drawings.

B. 120 VAC power wiring shall be of #12 AWG solid conductor or larger as required.

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION

A. The EMCS supplier shall provide a pre-construction coordination meeting with the affected trades to ensure a cooperative efficient process of installation. The invited trades shall include the general contractor, mechanical contractor, electrical contractor, test and balance contractor, commissioning provider, owner's representative, consulting engineer and others with a direct interest in the coordination of the affected systems. The EMCS contractor shall provide an outline of the meeting agenda highlighting the construction schedule, coordination with mechanical and electrical trades. Provide a sign-in sheet and submit it through the attendees along with a summary of the meeting notes for future reference.

3.2 INSPECTION DURING INSTALLATION

A. Provide a technician to assist the Engineer or Owner's Representative with inspections made during the installation period that are required to review the progress and quality of ongoing work. The engineer/owner's representative shall generate field observation reports on the findings of the inspection. The engineer or owner's representative shall advise the EMCS contractor during the inspection of any concerns noted with respect to the installation and shall repeat the concerns in writing as soon as possible after the inspection is completed. The EMCS contractor shall take corrective action to meet the requirements of the specifications. Upon correction, the EMCS contractor shall submit written documentation through the contractors to the engineer.

3.3 INSTALLATION OF COMPONENTS

A. Provide all interlock and control wiring. All wiring shall be installed in a neat and professional manner in accordance with specification Division 26 and all national, state and local electrical codes.

B. All wiring shall be installed as continuous lengths with no splices permitted between termination points.

C. Provide wire and wiring techniques recommended by equipment manufacturers. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the Owner's Representative prior to rough-in. Provide auxiliary pilot duty relays on motor starters as required for control function.

D. Maximum pulling, tension, and bend radius for wiring and cable installation, as specified by the manufacturer, shall not be exceeded during installation.

E. Electrical Contractor shall provide 120 or 277 volt power at a junction box within 48” of the controller. The BAS Contractor shall coordinate with the Electrical Contractor to identify locations of power requirements prior to the installation of the controls.

F. Conduit for control wiring shall be provided whenever one of the following conditions exists:

1. Conduit is indicated on the drawings or specifically required by the specifications.

2. Cabling runs through inaccessible areas such as within partitions/walls, above closed in ceilings, under floor; within trenches and underground; on the exterior of the building; exposed on the surface of the building; when encased in concrete or other material that makes the cable inaccessible or when located such that access to the cable is not readily obtained.

3. Cable within mechanical, telecommunications and electrical equipment rooms and control rooms.

4. Conduit shall be installed, inside wall from sensor box to above the wall, for all wall mounted temperature, humidity and CO2 sensors.

G. Size of conduit shall be in accordance with the manufacturer’s recommendations, specifications of Division 26, and NEC requirements.

H. Secure conduit with conduit clamps fastened to the structure and spaced according to Division 26 and code requirements. Conduit shall not be hung on flexible duct straps or tie rods. Conduit shall not be run on or attached to ductwork.

I. Control wiring located above accessible ceilings may be plenum rated cable. Plenum rated cable shall be neatly bundled and routed parallel or perpendicular to building surfaces.

J. Where plenum rated cable is installed without conduit, it shall be supported from or secured to the building structure. Cables shall be supported independently by cable hooks and shall not be supported by or secured to ductwork, electrical conduits, piping, or ceiling suspension systems. Multiple cables are to be dressed every 5 ft. to 7 ft. Cables shall be supported at a maximum of 10 ft. intervals with a maximum cable sag of 6" between supports.

K. Control wiring located in underground conduits shall be provided with direct-burial-rated insulation.

L. When communication bus enters or exits a building, a surge suppressor shall be installed. The surge suppressor shall be installed according to the controls manufacturer's instructions.

M. Provide sleeves for all cable and conduit passing through walls, partitions, structural components, floors and roof. Maintain fire rating at all penetrations through fire rated construction.

N. All communication wiring shall be labeled to indicate origination and destination data.

O. All sensor wiring shall be labeled to indicate the origination (at the device) and destination of data (at the control panel). The description shall indicate the type and location of the control device such as "AHU-1 SA temp" or "VAV 1-1 space temp".

P. Wall temp sensors at 48" above the finished floor to comply with ADA requirements and to match the height of the light switches. Mount humidity sensor at equal height to wall temperature sensor.

Q. Outdoor pressure sensors shall be installed a minimum of five feet above the roof surface and shall be free of immediate obstructions and sources of turbulence that could affect pressure readings. Sensors shall be attached to the top of roof mounted equipment or provided with stand-alone vertical support if no roof mounted equipment is available. Sensor tubing shall be routed into the building through a sealed weathertight penetration. Provide a heat trap loop in the sensor tubing immediately below the roof.

3.4 VERIFICATION REQUIREMENTS

A. Verification shall be provided by the EMCS contractor to demonstrate and confirm that the installed system complies with the specifications and the control sequences of operation herein specified. upon completion of the verification process the EMCS contractor shall demonstrate to the engineer or owner's representative the functionality of the control system devices are in compliance with the contract documents.

B. Technicians provided by the EMCS contractor shall be factory trained and qualified in the operation of the provided control system. The EMCS contractor shall provide, if requested, the factory training certificates of the individuals providing the verification services on this project.

C. Verification tools, applicable to the system provided, shall be utilized by the factory-trained technicians for proper verification of system operation and functionality. Temperature verification sensors shall be NIST certified within the last 12 months. Meters such as Fluke 52 series or better shall be utilized. Use of non-certified meters may require the system to be re-verified with certified meters at no cost to the owner.

D. Documentation of the verification process shall be provided per the project general conditions in electronic PDF format as required. Documentation shall include the following forms:

1. Project System Verification Forms for each controller provided on the project to verify the proper function of each controller, control device and system component provided.

2. Panel Verification Forms for each control panel to document the proper installation and function of each control panel provided.

3. Sequence of Operation Verification Forms for each piece of controlled equipment to confirm compliance of the control system with the specified sequences of operation.

4. Not providing proper documentation for each control devices, panel, or system, upon request by the engineer or owner's representative, may require the EMCS contractor to re-verify the applicable systems at no additional cost to the owner.

E. After completion of the verification, the EMCS contractor shall be able to demonstrate the sequence of operations for each system to the engineer and the owner's representative.

F. Equipment checkout sheets are to be produced by this contractor showing checkboxes and compliance with the following procedures for each piece of equipment and turned over to the owner and/or mechanical engineer.

3.5 COLORGRAPHICS

A. The colorgraphics shall be provided for the EMCS system prior to system acceptance and owner training.

B. The colorgraphics provided shall include the following as a template. Provide forward and backward links on the graphic.

1. Site plan with link to overall building plan including detached buildings. The site plan shall be referenced to an automatically updated aerial view or map view of the area such as Google Maps or Bing Maps. Provide link to proceed to the overall building floor plan.

2. The overall building plan shall indicate space temperature conditions referenced by the color of the zone. Specific details of the zone temperatures and equipment are not required. Provide a link to the floor plan wings, upper floors and remote buildings.

3. The floor plan colorgraphics shall indicate the space temperatures by color references. Additional information shall indicate the space temperature, the occupancy of the zone, air handling units, VAV terminals and ductwork with diffusers. A link at each terminal unit or AHU shall automatically connect the system operator to the equipment colorgraphic.

4. The colorgraphics for the equipment shall as a minimum be equal to the points from the input/output summary or control schematic. Primary control devices as required by the sequences of operation shall also be provided.

5. Control points from equipment that are integrated into the EMCS via BACnet shall be provided to convey the operating conditions of the attached equipment. Coordination of the integration points shall be accomplished during the submittal phase. The EMCS contractor shall provide a list of all integrated points on their submittal.

3.6 ENERGY MONITORING PROGRAMMING AND GRAPHICS

A. The EMCS shall be programmed to include a dedicated graphics page for energy monitoring.

B. The kW and kWH data acquired from each power meter shall be categorized within the EMCS by the following end-uses.

1. Total HVAC system loads

2. Interior lighting loads

3. Exterior lighting loads

4. Plug loads

5. Process loads

6. Building operations and other miscellaneous loads

C. The EMCS shall provide a graphic representation to show instantaneous real-time energy consumption data and shall provide hourly, daily, monthly, and yearly energy consumption data. Where multiple meters are used to measure an end-use category, the graphic representation for that end-use category shall include data from the individual meters as well as a total for the associated category. The graphic representation shall also include time and date of the highest peak demand for the current month and year as well as prior months and years for stored data. Demand thresholds may be set to adjust and shed loads in order to reduce peak consumption.

D. All meter data collected shall be stored for a minimum of 36 months and shall have the ability to be trended by building operation and management personnel on an hourly, daily, monthly, and yearly basis using the previous 36 months of stored data.

3.7 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Startup testing documentation: Prepare the checklist documenting startup testing of each input and output device, with technician's initials and date certifying each device has been tested and calibrated prior to acceptance testing. This document shall indicate proof that the following functions have been commissioned and shall be included in the as-built documentation: short to ground check, configuration of trends, confirmation that color-graphics are accurately representing actual systems, point to point checkout, all damper and valve actuators respond to input change, control modules are addressed and have functional descriptors, specified interlocks are functional, calibration report of all sensors, discrete outputs respond to time schedule or manual enable command.

B. Demonstration. Prior to acceptance, demonstrate the following performance tests to demonstrate system operation and compliance with specifications.

1. Engineer, owner’s representative and mechanical contractor shall be invited to observe and review system demonstration. Provide attendees at least 10 days notice.

2. Demonstration shall follow process approved as part of the submittal and shall include complete checklists and forms for each system as part of system demonstration.

3. Demonstrate actual field operation of each sequence of operation as specified. Demonstrate calibration and response of any input and output points requested by engineer or owner’s representative.

4. Demonstrate complete operation of operator interface including review of color-graphics, time schedules, trend logs, alarm notification, functionality of tablet PC operation.

a. PID loop response. Supply graphical trend data output showing each PID loop's response to a set point change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be selectable from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show set point, actuator position, and controlled variable values.

b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand limiting setpoint, and status of set points and other affected equipment parameters.

c. Trend logs for each system. Trend data shall indicate set points, operating points, valve positions, and other data as specified. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.

1) Once seven (7) days of trending data has been collected, the trend logs shall be exported to pdf format and submitted to the engineer, owner and commissioning provider for review. Trends shall be set up for the following points at a minimum as applicable:

   (a) Chillers

      (1) Start/stop

      (2) Entering water temperature

      (3) Leaving water temperature

   (b) Boilers

      (1) Start/stop

      (2) Entering water temperature

      (3) Leaving water temperature

   (c) Pumping systems

      (1) Start/stop

      (2) Speed command

      (3) Differential pressure set point

      (4) Differential pressure (system)

   (d) Packaged air handling units

      (1) Start/stop

      (2) Discharge air temperature

      (3) Outdoor air damper position

      (4) Space temperature set point

      (5) Space temperature

      (6) Outside air temperature

   (e) Hydronic air handling units

      (1) Start/stop

      (2) Discharge air temperature

      (3) Outdoor air damper position

      (4) Outdoor air flow rate set point

(5) Outdoor air flow rate

(6) Space temperature set point

(7) Space temperature

(8) Space humidity

(9) Fan speed command

(10) Static pressure set point

(11) Static pressure

(f) Zones: 100% of temperature zones in 15-minute intervals

(1) Space temperature set point

(2) Space temperature

(3) Carbon dioxide concentration

(g) Exhaust fans

(1) Start/stop

(2) Status

(h) Outside air conditions

(1) Outdoor air temperature

(2) Outdoor air humidity

5. Alarms and Interlocks. Check each alarm with an appropriate signal at a value that will trip the alarm. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction. Alarm verification shall include temperatures exceeding alarm threshold (high and low), fan failure safety, duct high static pressure switch, freezestat, and smoke detector shutdown.

6. Tests that fail to demonstrate proper system operation to the engineer shall be repeated after contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

C. Owner Acceptance.

1. After tests described in this specification are performed to the satisfaction of both engineer and owner’s representative, the engineer shall accept the control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond EMCS contractor's control. Engineer shall provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved by the engineer.

3.8 DEMONSTRATION AND OWNER TRAINING

A. Furnish basic operator training for multiple persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 16 hours: 8 hours instructor time for onsite training and 8 hours of hands on class environment training. Training sessions may be provided in 4-hour increments as approved by the owner's representative.

1. Change/modify temperature setpoints.

2. Change/modify time of day, holiday and override schedules.

3. Display, create, and modify trends of system points.

4. Update room numbers on the color-graphics.

B. Demonstrate complete and operating system to Owner. Provide written documentation listing the attendees of the specified training with sign-in sheet and training time and date.

3.9 SEQUENCE OF OPERATIONS

A. Refer to the Mechanical Drawings for project control schematics and sequence of operations.

END OF SECTION

SECTION 23 21 13 - ABOVE GROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 WORK INCLUDED

A. Pipe and pipe fittings.

B. Flanges, unions, dielectric connections, and couplings.

C. Valves.

D. Heating water piping system.

E. Chilled water piping system.

F. Condenser water piping system.

G. Condensate drain piping.

1.3 RELATED WORK

A. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping

B. Section 23 05 29 - Hangers and Supports for Piping and Equipment - HVAC

C. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

D. Section 23 05 53 - Identification for HVAC Piping and Equipment

E. Section 23 07 19 - HVAC Piping Insulation

1.4 REFERENCES

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

C. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2024.

D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.

E. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.

F. ASME B31.1 - Power Piping; 2024.

G. ASME B31.3 - Process Piping; 2024.

H. ASME B31.9 - Building Services Piping; 2025.

I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.

J. ASSE 1079 - Performance Requirements for Dielectric Pipe Unions; 2012.

K. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.

N. ASTM B32 - Standard Specification for Solder Metal; 2020.

O. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2026.

P. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.

Q. ASTM D1384 - Standard Test Method for Corrosion Test for Engine Coolants in Glassware; 2005.

R. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).

S. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

T. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).

U. ANSI/AWWA C110 - Ductile-Iron and Gray-Iron Fittings 3 in. through 48 in., for Water and Other Liquids.

V. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

W. ASTM B32 - Solder Metal.

1.5 QUALITY ASSURANCE

A. Foreign made pipes and fittings will not be acceptable.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

D. Welder’s Certification: In accordance with ASME BPVC-IX.

1.6 SUBMITTALS

A. Submit product data under provisions of Division One.

B. Include data on pipe materials, pipe fittings, valves, and accessories.

C. Include welder’s certification of compliance with ASME BPVC-IX.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division One.

B. Store and protect products under provisions of Division One.

C. Deliver and store valves in shipping containers with labeling in place.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, proper storage and dunnage, completing sections of the work, and isolating parts of completed system. Tape will not be allowed as an acceptable end cover.

PART 2 - PRODUCTS

2.1 CHILLED AND HEATING WATER AND GLYCOL PIPING

A. Steel Pipe Sizes 2 Inches and Smaller: ASTM A53/A53M, Schedule 40, black.

1. Fittings: ASTM A47/A47M, ASME B16.3, malleable iron.

2. Joints: Threaded.

B. Steel Pipe Sizes 2-1/2 Inches and Larger: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black.

1. Fittings: ASTM A234/A234M, ASME B16.9, wrought steel butt-welded type fittings.

2. Joints: Welded per ASME BPVC-IX.

2.2 CONDENSER WATER PIPING

A. Steel Pipe Sizes 2 Inches and Smaller: ASTM A53/A53M, Schedule 40, black.

1. Fittings: ASTM A47/A47M, ASME B16.3, malleable iron.

2. Joints: Threaded.

B. Steel Pipe Sizes 2-1/2 Inches and Larger: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black.

1. Fittings: ASTM A234/A234M, ASME B16.9, wrought steel butt-welded type fittings.

2. Joints: Welded per ASME BPVC-IX.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M, Schedule 40, galvanized.

1. Fittings: Galvanized cast iron, or ASTM A47/A47M, ASME B16.3, malleable iron.

2. Joints: Threaded, or grooved mechanical couplings.

B. Copper Drainage Tubing: ASTM B306, DWV.

1. Fittings: ASME B16.23 cast copper alloy solder joint DWV fittings or ASME B16.29 wrought copper alloy solder joint DWV fittings.

2. Joints: Soldered joints made in accordance with ASTM B828 using ASTM B32 Alloy Grade Sn50/Pb50 solder.

2.4 FLANGES, UNIONS, DIELECTRIC CONNECTIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under: Provide 150 psi malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.

B. Pipe Size Over 2 Inches: Provide 150 psi forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; 1/16 inch thick preformed neoprene bonded gasket.

C. Dielectric connections for pipe sizes 2 inches and under: Provide dielectric unions, rated at 180°F at 250 psi in compliance with ASSE 1079.

D. Dielectric connections for pipe sizes larger than 2 inches: Provide dielectric flanged pipe fittings, rated to 180°F at 175 psi in compliance with ASME B16.1.

E. Grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods. All grooved components shall be of one manufacturer, and conform to local code approval and/or is listed by ASME B31.1, ASME B31.3, ASME B31.9, ASME, UL/ULC. FM, IAPMO or BOCA. Grooved end manufacturer to be ISO 9001 certified. Grooved couplings shall meet the requirements of ASTM F1476. Manufacturer shall be Victaulic, Anvil Gruvlok, or Shurjoint. Can be utilized only in mechanical rooms or cooling tower areas.

2.5 ACCEPTABLE MANUFACTURERS - VALVES

A. Milwaukee

B. Crane

C. Nibco

D. Apollo

E. Bray

F. Kitz

2.6 ACCEPTABLE MANUFACTURERS - VALVES (GROOVED ONLY)

A. Victaulic

B. Anvil Gruvlok

C. Shurjoint

2.7 GATE VALVES

A. Up to 2 Inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, single wedge or disc, threaded ends.

B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged ends.

2.8 GLOBE VALVES

A. Up to 2 Inches: Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable stainless steel disc, threaded ends, with back seating capacity.

B. Over 2 Inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.9 BALL VALVES

A. Up to 2 Inches: Bronze two-piece body, 600 PSI full port, stainless steel ball and stem, teflon seats and stuffing box ring, lever handle, and balancing stops, threaded ends.

B. Over 2 Inches: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, or gear drive hand wheel for sizes 10 inches (250 mm) and over, flanged.

C. Ball valves installed in insulated lines shall have stem extensions compatible with up to 2” of insulation. Extensions shall be non-metallic equal to Nibco “nib-seal”.

2.10 PLUG COCKS

A. Up to 2 Inches: Bronze body, bronze tapered plug, non-lubricated, teflon packing, threaded ends, with one wrench operator for every ten plug cocks.

B. Over 2 Inches: Cast iron body and plug, pressure lubricated, teflon packing, flanged ends, with wrench operator with set screw.

2.11 BUTTERFLY VALVES

A. Iron body, aluminum bronze or stainless steel disc, resilient replaceable seat for service to 180 degrees F lug or grooved ends, extended neck, infinite position lever handle with memory stop. Valve shall be rated at full working pressure with downstream flange removed in either direction.

2.12 SWING CHECK VALVES

A. Up to 2 Inches: Bronze 45 degree swing disc, threaded ends.

B. Over 2 Inches Iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged or grooved ends.

2.13 SPRING LOADED CHECK VALVES

A. Iron body, bronze trim, stainless steel spring, aluminum bronze disc, threaded, grooved, wafer or flanged ends.

2.14 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems.

E. Provide extended necks for all vents, thermometer wells, pressure gauge wells, pet cocks and pete’s plugs.

3.2 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Branch tap connections to piping mains shall be from the top of the pipe.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.

F. Provide clearance for installation of insulation, and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08.

H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

J. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Division 09.

K. Install valves with stems upright or horizontal, not inverted.

L. All grooved components (couplings, fittings, valves, gaskets, and specialties) shall be of one manufacturer.

M. Grooved manufacturer shall provide on-site training for contractor's field personnel by a factory trained representative in the proper use of grooving tools, application of groove, and the product installation. Factory trained representative shall periodically visit the job site and inspect installation. Contractor shall remove and replace any improperly installed products.

3.3 APPLICATION

A. Use grooved mechanical couplings and fasteners only in mechanical rooms or cooling tower area.

B. Install unions downstream of valves, and at equipment or apparatus connections.

C. Provide non-conducting dielectric connections wherever joining dissimilar metals.

D. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

E. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

F. Install plug valves for throttling, bypass, or manual flow control services.

G. Provide spring loaded check valves on discharge of condenser and chilled water pumps.

H. Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

I. Use only butterfly valves in condenser water systems for throttling and isolation service.

J. Use lug end butterfly valves to isolate equipment.

K. Provide chain operated butterfly valve for installations at 12 feet or higher.

L. Provide 3/4-inch ball (drain) valves equal to Nibco T-585-70-HC at main shut-off valves, low points of piping, bases of vertical risers, and at equipment and pipe to nearest drain.

M. Provide automatic air vents at all high points and air pockets in the system. Where automatic air vents are installed above a ceiling or in other concealed locations, provide vent tubing to nearest drain.

N. Provide manual air vents as indicated on details and drawings.

3.4 CONDENSATE DRAIN PIPING

A. Drain piping from each unit shall be extended to the nearest floor drain or condensate drainage system. Drains shall be of the size indicated but not less than the full size of the drain pan connections.

B. Use plugged tees in lieu of elbows.

C. Slope all drain lines 1/8" per foot, minimum.

D. Provide auxiliary drain pan on all AHU's above ceiling with auxiliary drain line routed to discharge in visually prominent area. Discharge location shall be coordinated with Architect.

3.5 PIPE FABRICATION AND INSTALLATION

A. All pipes shall be cut accurately to measurements established at the site and shall be worked into place without springing or forcing.

B. Piping layout and installation shall be made in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance from other work. Particular attention shall be given to piping in the vicinity of equipment; layout shall be made in such manner as to preserve maximum access to the various equipment parts for maintenance.

C. All changes in directions shall be made with fittings; field bending and mitering of pipe is prohibited.

D. Air vents and air chambers shall be installed as hereinafter specified.

3.6 OFFSETS AND FITTINGS

A. Due to the small scale of the Drawings, it is not possible to indicate all offsets, fittings, etc. which may be required. The Contractor shall carefully investigate structural and finish conditions affecting the Work, and shall take such steps as may be required to meet such conditions at no additional cost to the Owner.

B. All piping shall be installed close to walls, ceilings and columns, (consistent with the proper space for covering, removal of pipe and special clearances), so as to occupy the minimum of space, and all offsets, fittings, etc., required shall be provided at no additional cost to the Owner.

3.7 SECURING AND SUPPORTING

A. All piping shall be adequately supported to line and grade, with due provisions for expansion and contraction.

B. Piping shall be supported on approved clevis type, split ring, or trapeze type hangers properly connected to the structural members of the building.

C. All insulated piping shall be fitted with suitable steel protection saddles.

D. Perforated bar hangers, straps, wire or chains will not be permitted.

3.8 ISOLATION VALVES

A. All piping systems shall be provided with line size shut-off valves located at risers, at branch connections to mains, and at other locations as indicated and required.

3.9 TESTING OF PIPING SYSTEMS

A. During the progress of the Work and upon completion, tests shall be made as specified herein and as required by Authorities Having Jurisdiction, including Inspectors, Owner or Engineer. The Engineer or duly authorized Construction Inspector shall be notified in writing at least 2 working days prior to each test or other Specification requirement which requires action on the part of the Construction Inspector.

B. Tests shall be conducted as part of this Work and shall include all necessary instruments, equipment, apparatus, and service as required to perform the tests with qualified personnel. Submit proposed test procedures, recording forms, and test equipment for approval prior to the execution of testing.

C. Tests shall be performed before piping of various systems have been covered or furred-in. For insulated piping systems, testing shall be accomplished prior to the application of any insulation.

D. All piping systems shall be tested and proved absolutely tight for a period of not less than 24 hours at a pressure of 150 psi(g) or 150% of design pressure, whichever is greater. Tests shall be witnessed by the Engineer or an authorized representative and pronounced satisfactory before pressure is removed or any water drawn off.

E. Leaks, damage or defects discovered or resulting from test shall be repaired or replaced to a like new condition. Leaking pipe joints, or defective pipe, shall be removed and replaced with acceptable materials. Test shall be repeated after repairs are completed and shall continue until such time as the entire test period expires without the discovery of any leaks, damage, or defects.

F. Wherever conditions permit, each piping system shall thereafter be subjected to its normal operating pressure and temperature for a period of no less than five 5 days. During that period, it shall be kept under the most careful observation. The piping systems must demonstrate the propriety of their installation by remaining absolutely tight during this period.

3.10 PIPE CLEANING, FLUSHING AND PURGING REQUIREMENTS AND PROCEDURES

A. The hydronic system shall be flushed and purged by contractor:

1. All mains, branches and zones shall be cleaned and treated per steps indicated below.

2. Owner/Engineer shall be given 72-hour notice prior to each step being performed.

B. Pre-flush requirements: Purpose is to get system ready for flushing and purging:

1. Piping must pass all required pressure testing and visual inspection for leaks.

2. All pumps shall be tested for rotation and properly aligned and lubricated.

3. Chemicals planning on being used must have certificate of assurance and product cut sheets presented to the owner/engineer prior to being used. All chemicals must be approved by the state prior to being added to the system, FDA approved and meet ASTM D1384. Automotive grade chemicals are not allowed.

4. Bypass all coils and heat exchangers by connecting the supply and return piping together.

5. Fill entire system with clean fresh potable water.

C. The flush requirements: Purpose is to completely remove all debris, dirt and air from hydronic system.

1. Add system cleaner that contains detergent and emulsifying agents to properly remove grease, grime and other debris for steel pipe. Volume of cleaner used shall be about 10% of total volume.

2. System shall be circulated for a minimum of 48 hours with water velocities of a minimum of 5 ft/sec or greater. After completed all strainers shall be removed and cleaned thoroughly. House pumps are acceptable to circulate water. House pumps or pump seals that are damaged during the flushing process shall be replaced at no cost to the Owner.

3. The system shall be entirely drained and flushed out to remove all of the cleaner from the system as quickly as possible after cleaning to prevent debris from settling. All strainers shall be removed and thoroughly cleaned after no more dirt and cleaner is visible in the flushing water as it leaves the system.

D. Final fill:

1. All air vents shall be opened to allow air to escape during filling.

2. Reconnect all flex connections to equipment.

3. System shall be drained and filled with a local domestic/softened water mixture as required by chemical treatment supplier. System shall be filled with pressure reducing valve at the specified fill pressure.

E. Purging: Purpose is to remove all air from the system:

1. System shall be circulated for a minimum of one hour with water velocities of a minimum of 5 ft/sec or greater until all visible air is removed.

F. Final chemical addition: Purpose is to install chemicals during inhibitor as required:

1. After the above final fill and purging has been completed and accepted by the engineer/owner the final chemical addition can be done.

2. Chemical treatment shall be added to the system after thoroughly mixing water per the manufacturer's recommendations. Chemical treatment shall include inhibitors. Quantities and concentrations of inhibitor/chemicals should be applied per the manufacturer's specifications and approval submittals.

3. System water shall be tested for chemical inhibitor concentrations, reserve alkalinity and PH. Reports shall be submitted to engineer/owner.

4. All records and documentation shall be kept and given to the owner upon completion.

END OF SECTION

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for Owner's use.

1.3 REFERENCES

A. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.

B. AHRI 730 (I-P) - Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers; 2013 (Reapproved 2014).

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

D. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2024, with Addendum (2025).

E. ASHRAE Std 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems; 2019, with Addendum (2026).

F. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

G. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

H. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.

I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.

J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.

K. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

L. AWS B2.2/B2.2M - Specification for Brazing Procedure and Performance Qualification; 2016.

1.4 SUBMITTALS

A. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

B. Piping: Submit data on pipe materials, fittings, and accessories.

C. Valves: Submit manufacturers catalog information with valve data and ratings for each service.

D. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes.

E. Welding Certificates: Submit per AWS B2.2/B2.2M and ASME BPVC-IX.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide for the systems as shown. Submit shop drawings of piping systems showing all traps, pipe sizes, and accessories; drawing to be marked "Approved" and signed by a representative of the Application Engineering Department of the condensing unit manufacturer. Pipe sizes shall be as recommended by unit manufacturer. Refer to piping schematic on Drawings.

2.2 MATERIAL

A. PIPE: Type ACR copper tubing, hard-drawn, per ASTM B280.

B. FITTINGS: Wrought copper per ASME B16.22.

C. JOINTS: Brazed joints with Sil-Fos filler metal per AWS A5.8M/A5.8.

2.3 ACCESSORIES

A. All accessories shall be UL listed and rated in accordance with AHRI 710.

B. On systems 7-1/2 tons and larger, each separate refrigerant circuit shall have a separate filter drier rated in accordance with AHRI 730 (I-P). Each filter drier shall have a replaceable core and a three valve bypass. The filter drier shall be full line size and installed in the refrigerant liquid line. The filter shall have a minimum 4-3/4 inches diameter shell with removable flange and gasket. Flange shall be tapped for 1/4 inch FPT access valve. Size filter-drier for maximum 2.0 psi pressure drop at evaporator operating temperature. Similar to Mueller Refrigeration model Drymaster micro-guard refillable filter series SD-485 through SD19217 or Sporlan catch-all.

C. On systems less than 7-1/2 tons, the filter drier shall be the sealed type; sizes as above. One drier per refrigerant circuit.

D. Liquid-Moisture Indicator shall be full line size, installed in liquid refrigerant line. Indicator shall be rated for the applicable refrigerant, system pressure and temperature; manufactured by Mueller Refrigeration or Sporlan.

E. Thermostatic expansion valve shall have adjustable super heat and be as manufactured by Sporlan.

F. Shut-off valves shall be bi-directional ball valves with welded body, brass ball with dual Teflon seals and integral relief port. Valves shall be rated for the applicable refrigerant, system pressure and temperature. Valves shall be manufactured by Mueller Refrigeration or Sporlan.

2.4 REFRIGERANT AND OIL

A. Contractor shall leave the refrigeration system with a full charge of refrigerant and oil and shall be responsible for the maintenance of a full charge of refrigerant and oil in the systems for a period of one year from date of Substantial Completion.

B. Should any leaks in the refrigeration system occur during the guarantee period, the Contractor shall eliminate such leaks and recharge system to a full charge of refrigerant and oil at no cost to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment and piping shall be installed in accordance with the manufacturer’s recommendations and printed installation instructions.

B. All items required for a complete and proper installation are not necessarily indicated on the Drawings or in the Specifications. Provide all items required as per manufacturer’s requirements.

C. Refrigerant piping shall be installed in accordance with ASHRAE Std 15 and ASHRAE Std 34.

D. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required.

E. Braze joints per AWS B2.2/B2.2M and AWS A5.8M/A5.8 requirements.

F. Pipe shall be cut square, reamed and chamfered, and shall be free from burrs and obstruction. Pipe ends shall have full-bore openings and shall not be undercut.

G. Refrigerant piping located in areas other than the room or space where the refrigerating equipment is located shall be identified with pipe markers that meet labeling requirements of ASME A13.1. Markers shall be manufactured by W.H. Brady Company or approved equal. The pipe identification shall be located at intervals not exceeding 20 feet on the refrigerant piping or pipe insulation. The minimum height of the identification lettering shall be 1/2". The pipe identification shall indicate the refrigerant designation and safety group classification of the refrigerant used in the piping system. For Group A2L and B2L refrigerants, the identification shall also include the following statement: “WARNING – Risk of Fire. Flammable Refrigerant.” For Group A2, A3, B2, and B3 refrigerants, the identification shall also include the following statement: “DANGER – Risk of Fire or Explosion. Flammable Refrigerant.” For any Group B refrigerant, the identification shall also include the following statement: “DANGER – Toxic Refrigerant”.

H. Refrigerant piping routed indoors shall be installed at a minimum of 7’-3” above finished floor when located above an area affording passage of occupants.

I. Refrigerant piping located indoors shall be located within building elements such as a ceiling or wall space or within a protective enclosure unless installed a minimum of 7’-3” above finished floor, within 6’-0” of the associated equipment or within a refrigerant machinery room.

J. Provide shield plates for refrigerant pipes containing Group A2, A3, B2L, B2, and B3 refrigerants that are located in concealed locations where piping is installed in studs, joists, rafters or similar member spaces, and are located less than 1-1/2 inches from the nearest edge of the member. Shield plates shall be constructed of steel, have a minimum thickness of 16 gage, and shall extend two inches beyond the edge of the piping on each side.

K. Refrigerant pipe and joints installed in the field shall be exposed for visual inspection and testing prior to being covered or enclosed.

3.2 FIELD QUALITY CONTROL

A. Test piping and refrigeration system in accordance with ASME B31.5, ASHRAE Std 147, and this section.

B. The refrigerant piping system shall be tested as a whole or separate tests shall be conducted for the low-pressure side and high-pressure side of the piping system.

1. Pressure Test:

a. Pressure test shall be performed using dry nitrogen.

b. The means used to pressurize the refrigerant piping system shall have on its outlet side a test pressure measuring device and either a pressure-limiting device or a pressure-reducing device. The test pressure measuring device shall have an accuracy of +/- 3% or less of the test pressure and shall have a resolution of 5% or less of the test pressure.

c. The system shall be pressurized for a period of not less than 60 minutes. Additional test gas shall not be added to the system after the start of the test.

d. Test pressure shall be at least 110% of the system design pressure.

e. Test pressure shall not exceed 130% of the design pressure of any component in the system.

f. The system shall not show loss of pressure on the test measuring device throughout the entirety of the test.

2. Evacuation and Leak Test:

a. Evacuate moisture completely by applying a commercial vacuum pump. Moisture indicator shall indicate a completely moisture-free condition at time of final inspection.

b. The vacuum pump shall run until the system indicates a vacuum of 500 microns.

c. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise for a minimum of 24 hours.

d. The system shall be flushed with the operating refrigerant and the vacuum pump connected and rerun to repeat the evacuation. Evaluation shall be performed under supervision of the Engineer.

C. Repair any and all leaks and retest as required.

END OF SECTION

SECTION 23 31 13 - METAL DUCTWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Low pressure ductwork.

B. Medium and high pressure ductwork.

C. Casings.

D. Underground buried ducts.

E. Exposed ductwork located indoors.

F. Grease exhaust ductwork serving Type I hoods.

G. Domestic range hood exhaust ductwork.

H. Dishwasher ductwork/Ductwork serving Type II hoods.

I. Shower/Locker room exhaust ductwork.

J. Laboratory fume hood exhaust ductwork.

K. Corrosive pool environment exhaust ductwork.

L. Corrosive pool environment supply and return ductwork.

M. Welding exhaust ductwork.

N. Paint hood exhaust ductwork.

O. Commercial dryer vent.

P. Duct leakage testing.

Q. Duct system protection.

R. Duct system cleaning.

1.2 RELATED SECTIONS

A. Division 9 - Finishes: Weld priming, weather resistant, paint or coating.

B. Section 23 02 00 - Basic Materials and Methods for HVAC

C. Section 23 05 29 - Hangers and Supports for Piping and Equipment - HVAC

D. Section 23 05 93 - Testing, Adjusting, And Balancing

E. Section 23 07 13 - Duct Insulation

F. Section 23 33 00 - Ductwork Accessories

G. Section 23 37 13 - Air Distribution Devices

1.3 REFERENCES

A. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2025b.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

D. NADCA ACR - The NADCA Standard for Assessment, Cleaning, and Restoration of HVAC Systems; 2025.

E. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

H. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

I. ASHRAE (FUND) ASHRAE Handbook - Fundamentals; Chapter 21 - Duct Design.

J. ASHRAE (HVACS) ASHRAE Handbook - HVAC Systems and Equipment; Chapter 19 - Duct Construction.

K. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

M. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

N. ICC (IECC) - International Energy Conservation Code.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer’s Qualifications: Firms with least 3 years of successful installation experience on projects with metal ductwork systems similar to that required for project.

1.5 GENERAL DESCRIPTION

A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

1.6 SUBMITTALS

A. Submit shop drawings, duct fabrication standards and product data under provisions of Division One.

B. Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work.

C. The contract documents are schematic in nature and are to be used only for design intent. The contractor shall prepare sheet metal shop drawings, fully detailed and drawn to scale, indicating all structural conditions, all plumbing pipe and light fixture coordination, and all offsets and transitions as required to permit the duct to fit in the space allocated and built. All duct revisions required as a result of the contractor not preparing fully detailed shop drawings will be performed at no additional cost.

1.7 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain indicated clear size inside lining. Where offsets or transitions are required, the duct shall be the equivalent size based on constant friction rate.

B. Low Pressure: Low pressure ductwork shall be rated for an operating pressure of 2”. Low pressure ductwork shall be defined as all return, exhaust, and outside air ducts, all supply ductwork associated with constant volume air handling units with a scheduled external static pressure of less than 2”, and all supply ductwork downstream of terminal units in variable volume systems.

C. Medium Pressure: Medium pressure ductwork shall be rated for an operating pressure of 4”. Medium pressure ductwork shall be defined as all supply ductwork extending from variable volume air handling units to terminal units in variable volume systems with air handling units having a scheduled external static pressure of less than 4”. The supply ductwork of constant volume air handling units having a scheduled external static pressure greater than 2” and less than 4” shall be rated for medium pressure.

D. High Pressure: High pressure ductwork shall be rated for an operating pressure of 6”, or the scheduled external pressure of the equipment it is connected to, whichever is greater. The supply ductwork of air handling units having a scheduled external static pressure greater than 4” shall be high pressure.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings, use sheet metal end caps on any lined duct exposed to the weather.

B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.

B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A653/A653M.

C. Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A480/A480M; Type 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.

D. Aluminum Sheet: Where indicated, provide aluminum sheet complying with ASTM B209, Alloy 3003, Temper H14.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

A. General: Non-combustible and conforming to UL 181, Class 1 air duct materials.

B. Flexible Ducts: Flexmaster U.S.A., Inc. Type 5M, Thermaflex MKE, ATCO #036 or approved equal.

1. Flexible ducts shall be corrosive resistant galvanized steel formed and mechanically locked to inner fabric with minimum 1-1/2" thick, R-6 insulation. Flexible duct shall be rated up to at least 10 in.w.g. positive pressure and shall have reinforced metalized outer jacket to comply with UL 181, Class 1 air duct.

C. Sealants: Hard-Cast “iron grip” or approved equal, non-hardening, water resistant, fire resistive and shall not be a solvent curing product. Sealants shall be compatible with mating materials, liquid used alone or with tape or heavy mastic.

D. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

1. For exposed stainless steel ductwork, provide matching stainless steel support materials.

2. For aluminum ductwork, provide aluminum support materials.

2.3 LOW PRESSURE DUCTWORK

A. Fabricate and support in accordance with latest SMACNA (DCS) Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by approved shop drawings. Obtain engineer's approval prior to using round duct in lieu of rectangular duct.

C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide airfoil-turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

E. Use crimp joints with bead for joining round duct sizes 6 inch smaller with crimp in direction of airflow.

F. Use double nuts and lock washers on threaded rod supports.

2.4 MEDIUM AND HIGH PRESSURE DUCTS

A. Fabricate and support in accordance with SMACNA (DCS) Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

B. Construct T's, bends, and elbows with radius of not less than 1½ times width of duct on centerline. Where not possible and where rectangular elbows are used, provide airfoil-turning vanes. Where acoustical lining is required, provide turning vanes of perforated metal with glass fiber insulation. Weld in place.

C. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

D. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

E. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

2.5 CASINGS

A. Fabricate casings in accordance with SMACNA (DCS) Standards and SMACNA High Pressure Duct Construction Standards and construct for operating pressures indicated.

B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gauge galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

C. Reinforce doorframes with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Provide clear wire glass observation ports, minimum 6 X 6 inch size.

D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge back facing and 22 gauge perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb./cubic foot minimum glass fiber media, on inverted channels of 16 gauge.

2.6 BURIED UNDERGROUND DUCTS

A. Buried ducts may be concrete encased sheet metal or fiberglass reinforced plastic as indicated.

2.7 EXPOSED DUCTWORK LOCATED INDOORS

A. Where ductwork is indicated to be exposed to view in occupied spaces, provide round or flat oval, double wall galvanized steel construction with spiral lockseam with perforated inner liner, United McGill Corporation model Acousti-k27 or approved equal.

2.8 GREASE EXHAUST DUCTWORK SERVING TYPE I HOODS

A. Fabricate in accordance with SMACNA (DCS) Standards, and NFPA 96.

B. Construct of 16 gauge carbon steel or 18 gauge stainless steel, using continuous external welded joints.

C. Slope all duct toward the kitchen hood or a grease reservoir so that grease cannot collect in any portion of duct per mechanical code.

2.9 DOMESTIC RANGE HOOD EXHAUST DUCTWORK

A. Fabricate in accordance with SMACNA (DCS) Standards.

B. Construct of minimum 26 gauge galvanized steel.

2.10 DISHWASHER DUCTWORK/DUCTWORK SERVING TYPE II HOODS

A. All ductwork shall be stainless steel, one gauge heavier than that required for galvanized steel duct.

B. Slope all duct to drain toward the dishwasher/hood or provide drain line to floor drain.

2.11 SHOWER/LOCKER ROOM EXHAUST DUCTWORK

A. All ductwork shall be stainless steel, one gauge heavier than that required for galvanized steel duct.

B. Slope all duct to drain out grilles or provide drain line to floor drain.

2.12 LABORATORY FUME HOOD EXHAUST DUCTWORK

A. Construct of 18 gauge type 316 stainless steel.

B. All welded construction.

2.13 CORROSIVE POOL ENVIRONMENT EXHAUST DUCTWORK

A. Construct of minimum 18 gauge aluminum.

1. All hangers, supports, hardware, and accessories shall be aluminum.

2.14 CORROSIVE POOL ENVIRONMENT SUPPLY AND RETURN DUCTWORK

A. Construct of double wall duct, minimum 18 gauge, type 3003-H14 aluminum inner and outer. Double wall duct shall be spiral lockseam outer with solid inner liner and fiberglass/glass mineral fiber insulation. Provide 2” thick insulation with minimum insulation density of 1.0 pcf.

1. All hangers, supports, hardware, and accessories shall be aluminum.

2.15 WELDING EXHAUST DUCTWORK

A. Construct of galvanized steel with spiral lockseam. Provide duct gauges, reinforcing, and sealing for operating pressures indicated.

B. Joints and fittings shall be flanged construction. All joints shall be gasketed or sealed.

2.16 PAINT HOOD EXHAUST DUCTWORK

A. Construct of 18 gauge, Type 316 stainless steel.

B. All welded construction.

2.17 COMMERCIAL DRYER VENT

A. Construct of 18 gauge, Type 316 stainless steel.

B. All welded construction.

C. Provide hard duct connection to dryer.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Obtain manufacturer's inspection and acceptance of fabrication and installation of ductwork at beginning of installation.

B. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

D. Connect terminal units to medium or high pressure ducts with 18 inches maximum length of flexible duct. Do not use flexible duct to change direction.

E. Connect diffusers or troffer boots to low pressure ducts with 5 feet maximum, 4 feet minimum, length of flexible duct. Hold in place with strap or clamp.

F. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

G. The interior surface of all ductwork shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.

H. All ductwork located outdoors shall be "crowned" to prevent water from ponding. Refer to 23 07 13 - Duct Insulation for additional requirements.

I. Where ducts pass through non-rated floors, provide structural angles for duct support. Where ducts pass through non-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches. Where ducts pass through rated interior partitions, rated exterior walls, or rated floors, install fire dampers or smoke dampers as required. Provide sleeves for dampers not provided with factory sleeve. Refer to Section 23 33 00 - Ductwork Accessories for fire and smoke damper requirements.

J. All angles shall be carried around all four sides of the duct or group of ducts. Angles shall overlap corners and be welded or riveted.

K. All ductwork shall be fabricated in a manner to prevent the seams or joints being cut for the installation of grilles, registers, or ceiling outlets.

L. All duct hangers shall be attached to building structure. Cutting slots in roof or floor decking for hanger straps to be cast in concrete is not acceptable.

3.2 INSTALLATION OF FLEXIBLE DUCTS

A. Maximum Length: For any duct run using flexible ductwork, do not exceed 5'-0" extended length.

B. Installation: Install in accordance with Section III of SMACNA (DCS).

3.3 REQUIREMENTS FOR DUCTS BURIED UNDERGROUND

A. Slope underground ducts to plenums or low pump-out points at 1:500. Provide access doors for inspection.

B. Coat buried, metal ductwork without factory jacket with one coat and seams and joints with additional coat of asphalt base protective coating.

C. Insulate buried supply duct runs over 50 feet long with one inch thick insulation covered with plastic vapor barrier.

D. Encase buried metal ductwork in 3 inch minimum of concrete. Provide adequate tie-down points to prevent ducts from floating during concrete placement. Introduce no heat into ducts for 20 days following placement of concrete.

3.4 REQUIREMENTS FOR UNIT CASINGS

A. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

3.5 REQUIREMENTS FOR GREASE EXHAUST DUCTWORK SERVING TYPE I HOODS

A. Provide residue traps in grease exhaust ducts at base of vertical risers with provisions for cleanout.

B. Provide access openings in each change in direction, located on sides of duct 1½" minimum from bottom, and fitted with grease-tight covers of same material as duct.

C. Use stainless steel for ductwork exposed to view.

3.6 REQUIREMENTS FOR DRYER VENT EXHAUST DUCT PROTECTION

A. Provide shield plates to protect dryer vent ducts that are in concealed locations where vent duct is installed in studs, joists, or similar framing member spaces, and are located less than 1-1/4" from the finished face of the framing member. Shield plates shall be constructed of steel, have a minimum thickness of 16 gage, and shall extend within two inches of sole plates and within two inches of top plates.

3.7 DUCTWORK APPLICATION SCHEDULE

A. Ductwork materials shall be provided to comply with the following:

AIR SYSTEM	MATERIAL
Low Pressure Supply	Galvanized Steel, Aluminum
Buried Supply or Return	Concrete, Glass Fiber Reinforced Plastic
Medium and High Pressure Supply	Galvanized Steel
Return and Relief	Galvanized Steel, Aluminum
General Exhaust	Galvanized Steel, Aluminum
Grease Exhaust	Carbon Steel, Stainless Steel
Domestic Range Hood Exhaust	Galvanized Steel
Dishwasher/Ductwork Serving Type II Hoods	Stainless Steel
Shower/Locker Room/Dryer Vent/Paint Hood Exhaust	Stainless Steel
Fume Hood Exhaust	Stainless Steel
Corrosive Pool Environments	Aluminum
Welding Exhaust	Galvanized Steel
Outside Air Intake	Galvanized Steel

Combustion Air	Galvanized Steel
Emergency Generator Ventilation	Carbon Steel

3.8 DUCTWORK HANGERS AND SUPPORTS

A. All ductwork shall be properly suspended or supported from the building structure. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Strap hanger shall be attached to the bottom of the ductwork, provide a minimum of two screws one at the bottom and one in the side of each strap on metal ductwork. The spacing, size and installation of hangers shall be in accordance with the recommendations of the latest SMACNA edition.

B. Wire shall not be used for permanent support or attachment components.

C. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor with sheet metal screws or rivets. The floor supports may also be secured to ducts by rods, angles or flat bar to the duct joint or reinforcing. Structural steel supports for duct risers shall be provided under this Division.

3.9 AIR DUCT LEAKAGE: (FROM SMACNA DUCT STANDARDS LATEST EDITION) TEST ALL DUCTWORK (DESIGNED TO HANDLE OVER 1,000 CFM) AS FOLLOWS:

A. Test apparatus

1. A source of high pressure air-a portable rotary blower or a tank type vacuum cleaner.

2. A flow measuring device consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly shall be accurately calibrated with its own calibration curve. Pressure and flow readings shall be taken with U-tube manometers.

B. Test Procedures

1. Test for audible leaks as follows:

2. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.

a. Start the blower with its control damper closed.

b. Gradually open the inlet damper until the duct pressure reaches 1.5 times the standard designed duct operating pressure.

c. Survey all joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.

3. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:

a. Start blower and open damper until pressure in duct reaches 50% in excess of designed duct operating pressure.

b. Read the pressure differential across the orifice on manometer No. 2. If there is no leakage, the pressure differential will be zero.

c. Total allowable leakage shall not exceed one (1) percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

d. Even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak which, must be corrected.

4. Testing Report

a. Contractor shall provide a testing report for each air system to the engineer. The report shall indicate the completion of testing and compliance with testing specification.

b. All duct testing reports shall be included in the final close out documents.

3.10 GREASE EXHAUST DUCT LEAKAGE: LIGHT TEST

A. Prior to the use or concealment of any portion of grease exhaust duct systems, a leakage test shall be performed on all grease exhaust duct as outlined below. Concealment shall be considered as anything that prevents visual inspection of the duct on all sides.

B. Test Apparatus

1. The light source shall be fully open as to emit light equally in all directions perpendicular to the duct walls.

2. The light source shall emit a minimum of 1,600 lumens.

C. Test Procedure

1. Visually test for leaks as follows:

a. The light source shall be passed through the entire duct system, including the hood to duct connection, with the light source emitting light perpendicular to the duct walls.

b. Each duct wall and duct joint shall be visually inspected from the outside of the duct as the light source passes each portion of the duct system.

c. If any light is visible from the outside of the duct, these leakage locations shall be marked for correction.

d. All leaks discovered during the visual test shall be corrected as required to prevent leakage.

e. After all repairs have been completed, the visual light test shall be repeated until no leaks are present.

2. Testing Report

a. Contractor shall provide a testing report for each grease exhaust duct system to the engineer. The report shall indicate the completion of testing and compliance with testing specification.

b. All duct testing reports shall be included in the final close out documents.

3.11 DUCT SYSTEM PROTECTION

A. Provide temporary closures at the ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation; provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

B. Provide temporary construction filters on air handling equipment and/or return air ductwork during construction to protect ductwork and equipment from dust.

C. Any ductwork stored on site with observable dirt or debris inside shall be cleaned by a third party.

D. If the air handling system has been operated without temporary construction filters or if the integrity of the temporary closures has been compromised, the contractor shall have the duct system cleaned per the following section.

3.12 DUCT SYSTEM CLEANING

A. For renovation projects and HVAC retrofit applications wherein existing duct systems are scheduled to be re-used, or where required by the Duct System Protection section above, the contractor shall have the existing duct systems cleaned in accordance with the current published standards of ASHRAE, NADCA ACR and as indicated below.

B. Duct system cleaning method used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment is assured.

C. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.

D. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes or regulations.

E. Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.

F. Duct cleaning method used shall not damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

G. Replace the fiberglass material if there is any evidence of damage, deterioration, delamination, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating.

H. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

I. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

J. Cleaning Report: Contractor shall provide a report to the Owner indicating the completion of duct cleaning per specification and areas of the duct system found to be damaged and/or in need of repair.

3.13 DUCT JOINTS AND SEAMS

A. All ductwork shall be constructed to Seal Class A, as referenced in SMACNA (DCS).

B. All non-welded joints and seams shall be sealed. This includes but is not limited to:

1. Transverse joints.

2. Longitudinal seams.

3. Duct wall penetrations.

4. Spin-ins, taps, and other branch connections.

5. Access doors, access panels, and duct connections to equipment.

C. Openings for rotating shafts shall be sealed with bushings.

END OF SECTION

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Volume control dampers.

B. Shutoff Dampers.

C. Round Duct Taps.

D. Conical Duct Taps.

E. Fire dampers.

F. Combination fire and smoke dampers.

G. Back draft dampers.

H. Air turning devices.

I. Flexible duct connections.

J. Duct access doors.

K. Duct test holes.

1.2 RELATED WORK

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

C. Section 23 31 13 - Metal Ductwork

1.3 REFERENCES

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

B. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

F. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

G. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

H. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division One.

B. Provide shop drawings for shop fabricated assemblies indicated, including volume control dampers duct access doors duct test holes. Provide product data for hardware used.

C. Submit manufacturer's installation instructions under provisions of Division 1, for fire dampers and combination fire and smoke dampers.

PART 2 - PRODUCTS

2.1 VOLUME CONTROL DAMPERS

A. Fabricate in accordance with SMACNA (DCS), and as indicated.

B. Fabricate splitter dampers of material same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.

C. Fabricate splitter dampers of double thickness sheet metal to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/2 inch diameter rod in self aligning, universal joint, action flanged bushing, with set screw.

D. Fabricate single blade dampers for duct sizes to 9-1/2 x 24 inch.

E. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inch.

1. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

2. On outside air, return air, and all other dampers required to be low leakage type, provide galvanized blades and frames, seven inches wide maximum, with replaceable vinyl, EPDM, silicone rubber seals on blade edges and stainless steel side seals. Provide blades in a double sheet corrugated type construction for extra strength. Provide hat channel shape frames for strength and blade linkage enclosure to keep linkage out of the air stream. Construction leakage not to exceed 1/2%, based on 2,000 fpm and 4 inch static pressure.

F. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

G. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.

H. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.2 SHUTOFF DAMPERS

A. Fabricate in accordance with SMACNA (DCS), and as indicated.

B. Provide Class I multi-blade damper of parallel blade pattern for all ductwork systems which penetrate the building thermal envelope in accordance with ICC (IECC) and ASHRAE Std 90.1 I-P.

1. Damper shall be constructed of one-piece 16 ga. roll-formed galvanized steel hat-shaped channel frame. Blades shall be 14 ga. roll-formed galvanized steel, airfoil type. Blade edge seals shall be neoprene gaskets mechanically locked to blade edge. Bearings shall be 304 stainless steel, oil-impregnated and self-lubricating sleeve type, turning in extruded holes in damper frame.

C. Shutoff dampers shall have an air leakage rate not greater than 4 cfm/ft^2 of damper surface area at 1.0 in.w.g. and shall be labeled by an approved agency when tested in accordance with AMCA 500-D for such purpose.

2.3 ROUND DUCT TAPS

A. Taps to trunk duct for round flexible duct shall be spin-in fitting with locking quadrant butterfly damper, model no. FLD-B03 by Flexmaster or approved equal.

2.4 CONICAL DUCT TAPS

A. Taps to trunk duct for primary air inlet to all VAV terminal units shall be conical fitting, model no. CB by Flexmaster or approved equal.

2.5 ACCEPTABLE MANUFACTURERS - FIRE DAMPERS AND COMBINATION FIRE AND SMOKE DAMPERS

A. Greenheck.

B. Louvers and Dampers Inc.

C. Ruskin.

D. Nailor Industries.

E. Pottorff.

2.6 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

B. Provide curtain type dampers of galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream. Provide factory sleeve for each damper.

C. Fabricate multiple blade fire dampers per UL with 16 gauge minimum galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

D. Fusible links, UL 33, shall separate at 165 degrees F. Provide adjustable link straps for combination fire/balancing dampers.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A, UL 555, UL 555S and as indicated.

B. Provide factory sleeve for each damper. Install damper operator on exterior of sleeve and link to damper operating shaft.

C. Fabricate with multiple blades with 16 gauge galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

1. Operators shall be spring return electric type suitable to operate on 120 VAC, 60 cycle.

2. Operators shall be UL listed and labeled.

2.8 SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, UL 555S and as indicated.

B. Motorized Smoke Dampers: multi-blade type, normally open with power on, close automatically when power is interrupted, UL-listed and labeled damper and damper operator.

2.9 ACCEPTABLE MANUFACTURERS - BACKDRAFT DAMPERS

A. Greenheck.

B. American Warming and Vent.

C. Louvers and Dampers Inc.

D. Ruskin.

E. Pottorff.

F. Substitutions: Under provisions of Division One.

2.10 BACKDRAFT DAMPERS

A. Gravity back draft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction.

B. Fabricate multi-blade, parallel action gravity balanced back draft dampers of 16 gauge galvanized steel, or extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

C. Gravity backdraft dampers shall have an air leakage not greater than 20 cfm/ft^2 where not less than 24 inches in either dimension and 40 cfm/ft^2 where less than 24 inches in either dimension. The rate of air leakage shall be determined at 1.0 in.w.g. when tested in accordance with AMCA 500-D for such purpose.

2.11 ACCEPTABLE MANUFACTURERS - AIR TURNING DEVICES

A. Young Regulator.

B. Titus.

C. Tuttle and Bailey.

D. Substitutions: Under provisions of Division One.

2.12 AIR TURNING DEVICES

A. On duct sizes less than 12 x 12, multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.

B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel or aluminum construction, with worm drive mechanism with 18 inch long removable key operator.

2.13 ACCEPTABLE MANUFACTURERS - FLEXIBLE DUCT CONNECTIONS

A. Metaledge.

B. Ventglass.

C. Substitutions: Under provisions of Division One.

2.14 FLEXIBLE DUCT CONNECTIONS TO AIR MOVING EQUIPMENT

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz. per sq. yd., approximately 6 inches wide, crimped into metal edging strip.

2.15 ACCEPTABLE MANUFACTURERS - DUCT ACCESS DOORS

A. Greenheck.

B. American Warming and Vent.

C. Ruskin.

D. Titus.

E. Substitutions: Under provisions of Division One.

2.16 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Review locations prior to fabrication.

C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover. Insulation shall be replaceable without field cutting or patching.

D. Access doors smaller than 12 inches square may be secured with sash locks.

E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.

F. Access doors with sheet metal screw fasteners are not acceptable.

2.17 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions.

B. Balancing Dampers

1. Provide at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and as required for air balancing. Use splitter dampers only where indicated.

2. All regulators mounted on externally insulated ductwork shall have 16 gauge elevated platforms at least 1/8 inch higher than the thickness of the insulation. Damper shaft shall have Ventlock No. 607 bearing mounted on ductwork within elevated platform. If duct is inaccessible the operating handle shall be extended and the regulator installed on the face of the wall or ceiling. Where regulators are exposed in finished parts of the building, they shall be flush type, Ventlock No. 666. All regulators shall be manufactured by Ventlock, or approved equal.

3. All dampers in lined ductwork shall have bushing to prevent damper damage to liner.

C. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

D. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

E. Provide gravity backdraft dampers or motorized shutoff dampers in accessible location nearest to exterior wall/roof penetrations and where indicated for all outdoor air intake and exhaust systems to automatically shut when the associated systems or spaces served are not in use.

F. Provide flexible duct connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Provide at least one inch slack at all flexible duct connections.

G. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated.

H. Provide duct access doors for inspection and maintenance of all fire dampers, smoke dampers, and combination fire/smoke dampers. Provide minimum 12 x 12 inch size access opening where duct size permits. All duct sizes that cannot accommodate a minimum 12 x 12 inch access opening shall be provided with a removable duct section to permit inspection and maintenance of the damper and its operating parts. Removable duct sections shall match the pressure class of the associated duct system, maintain 100 percent of the duct free area, and utilize gaskets and clamp type draw latches to allow removal and reinstallation without the use of tools.

I. Provide duct test holes where indicated and required for testing and balancing purposes.

END OF SECTION

SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 WORK INCLUDED

A. Centrifugal roof ventilators

B. Ceiling and inline ventilators

C. Roof supply fans

D. Utility fans

E. Kitchen hood upblast roof exhaust fans

1.3 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting, And Balancing

E. Section 23 09 63 - Energy Management and Control System (EMCS)

F. Section 23 33 00 - Ductwork Accessories

1.4 REFERENCES

A. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.

B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

C. AMCA 211 - Certified Ratings Program Product Rating Manual for Fan Air Performance; 2022, with Editorial Revision (2023).

D. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

F. AMCA 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance; 2016.

G. ASCE 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2016.

H. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

J. FLA (FBC-B) - Florida Building Code: Building (8th Edition); 2023, with Supplement (2024).

K. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. Miami (APD) - Approved Products Directory; Miami-Dade County; Current Edition.

N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

P. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

Q. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

R. UL 705 Supplement SC - (Formerly UL-762) - Standard Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition, Including All Revisions.

S. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition, Including All Revisions.

1.5 QUALITY ASSURANCE

A. UL Compliance: Fans shall be designed, manufactured, and tested in accordance with UL 705.

B. UL Compliance: Fans and components shall be UL listed and labeled.

C. Nationally Recognized Testing Laboratory Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70.

F. Sound Power Level Ratings: Comply with AMCA 301. Test fans in accordance with AMCA 300. Fans shall be licensed to bear the AMCA 300 Seal.

G. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA 210.

H. Motors for fans that are not less than 1/12 hp (0.082 kW) and less than 1 hp (0.746 kW) shall be electronically commutated motors per ICC (IECC) and ASHRAE Std 90.1 I-P.

I. High Wind models shall be analyzed and stamped by a state license P.E. to the ASCE 7-16 Standard which meets the ICC (IBC), FLA (FBC-B), and Miami (APD) codes.

J. Each High Wind model is subject to be certified by a Nationally Recognized Testing Laboratory to ASTM E330/E330M.

1.6 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

B. Product data for selected models, including specialties, accessories, and the following:

1. Certified fan performance curves with system operating conditions indicated.

2. Certified fan sound power ratings.

3. Motor ratings and electrical characteristics plus motor and fan accessories.

4. Materials, gages and finishes, include color charts.

5. Dampers, including housings, linkages, and operators.

6. Full color paint samples.

C. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

D. Coordination drawings, in accordance with Division 23, Section "Basic Materials and Methods", for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling. Show the following:

1. Roof framing and support members relative to duct penetrations.

2. Ceiling suspension members.

3. Method of attaching hangers to building structure.

4. Size and location of initial access modules for acoustical tile.

5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.

E. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer installed wiring and field installed wiring.

F. Product certificates, signed by manufacturer, certifying that their products comply with specified requirements.

G. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23, Section "Basic Materials and Methods".

H. Provide delegated design submittal for equipment anchorage as required in specification 23 02 00 – Part 1.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Fans shall be stored and handled in accordance with the unit manufacturer’s instructions.

B. Lift and support units with the manufacturer`s designated lifting or supporting points.

C. Disassemble and reassemble units as required for movement into the final location following manufacturer`s written instructions.

D. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.9 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner’s operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Greenheck Fan Corporation

B. Loren Cook Company

C. Pennbarry

D. ACME

E. Twin City Fan and Blower

2.2 GENERAL DESCRIPTION

A. Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.

B. Fans and Shafts shall be statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

C. Provide factory baked-enamel finish coat after assembly. Color for roof mounted fans shall be chosen by Architect during the submittal process.

2.3 CENTRIFUGAL ROOF VENTILATORS

A. Fan shall be a spun aluminum, centrifugal, roof mounted, direct driven or belt driven as indicated.

B. Fan shall be UL 705 listed. Fan shall bear the AMCA certified ratings seal for sound and air performance.

C. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure.

D. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. A discharge baffle conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections.

E. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Unit shall bear an engraved aluminum nameplate and shall be shipped in transit tested packaging.

F. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA 204, balance quality and vibration levels for fans.

G. Motor shall be heavy duty type with permanently lubricated sealed ball bearings.

H. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty re-greaseable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

I. Accessories: The following accessories are required.

1. Disconnect Switch: Non-fusible type, with thermal overload protection, mounted inside fan housing, factory-wired through an internal aluminum conduit.

2. Bird Screens: Removable ½ inch mesh, 16 gauge, aluminum or brass wire.

3. Dampers: Gravity backdraft damper or motorized shutoff damper mounted in accessible location. Refer to 23 33 00 - Ductwork Accessories.

4. Roof Curbs: Prefabricated, minimum 12 inch high, heavy-gauge, galvanized steel; mitered and welded corners; 2 inch thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Curb heights shall be increased as required to maintain a minimum height of 8 inches above adjacent roofing surface. Size as required to suit roof opening and fan base. Roof curb shall match roof slope so that the curb is level.

2.4 CEILING AND INLINE VENTILATORS

A. Ceiling and inline ventilators shall be direct drive or belt drive as indicated, centrifugal blower type. Fan wheel shall be constructed of galvanized steel and shall be dynamically balanced. The housing shall be constructed of minimum 20 gauge corrosion resistant galvanized steel and acoustically insulated for quiet operation. Blower and motor assembly shall be easily removable from the housing without disturbing the ductwork. The motor shall be permanently lubricated with built-in thermal overload protection and shall be factory tested prior to shipment. The ceiling ventilators shall be furnished standard with a powder-painted white steel grille.

B. Ventilators shall be certified and licensed to bear the AMCA Seal for Air and Sound Performance. Ventilator performance shall be based on tests and procedures performed in accordance with AMCA 211 and comply with the requirements of the AMCA Certified Ratings Program. Fan sound power level ratings shall be based on tests and procedures performed in accordance with AMCA 311 and comply with the requirements of the AMCA Certified Ratings Program. Ventilators shall be UL listed and CSA certified.

C. Accessories: The following accessories are required.

1. Dampers:

a. Aluminum backdraft damper.

b. Motor-operated volume control damper.

c. L listed ceiling radiation damper for ceiling fans comply with NFPA 90A rated for 3 hours

2. Disconnect Switch: Nonfusible type with thermal overload protection.

3. Speed Controls: Fan mounted, solid state speed controller.

2.5 ROOF SUPPLY FANS

A. Roof-mounted, filtered air supply units are of the belt-driven, double width, double inlet (DWDI), forward curved centrifugal blower type. The unit's blower assembly shall be mounted on vibration isolators. Motor drives shall be machine cast iron and variable pitch and shall be factory set to the specified RPM. Belts shall be non-static and oil resistant. Both motor and blower bearings shall be permanently lubricated with sealed ball bearings. The blower housing shall be fabricated of heavy gauge painted steel.

B. Fan shall be UL 705 listed and shall bear the AMCA certified rating seal for sound and air performance.

C. Units housing shall be minimum 18 gauge extruded aluminum with a removable aluminum cover. The insulated cover shall be held in place with bolts for easy access to fan components.

D. Filters shall be permanent, one inch, washable, aluminum type and shall be easily removed for cleaning. Units carry the AMCA Certified Ratings Seal for air performance with filters in place.

E. Accessories: The following items are required.

1. Disconnect Switch: Non-fusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.

2. Bird Screens: Removable ½ inch mesh, 16 gauge, aluminum or brass wire.

3. Dampers: Gravity backdraft damper or motorized shutoff damper mounted in accessible location. Refer to 23 33 00 - Ductwork Accessories.

4. Roof Curb: Prefabricated, minimum 12 inch high, heavy gauge, galvanized steel; mitered and welded corners; 2 inch thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Curb heights shall be increased as required to maintain a minimum height of 8 inches above adjacent roofing surface. Size as required to suit roof opening and fan base.

2.6 UTILITY FANS

A. Fans shall be of the direct driven or belt driven utility fan type as indicated with a single width, single inlet housing in AMCA arrangement 10.

B. The housing shall be constructed of minimum 14 gauge steel with continuously welded or lock formed seams permitting no air leakage. The housing shall be field rotatable to any of the eight standard discharge positions. Housing and bearing supports shall be constructed of minimum 10 gauge welded steel members to prevent vibration and rigidly support the shaft and bearings. Side access inspection port shall be provided for access to the motor compartments.

C. The fan wheel shall be of the forward curved type C, non-overloading backward inclined, centrifugal fan type and constructed of heavy gauge steel.

D. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency.

E. Motors shall be permanently lubricated, heavy duty, ball bearing type carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. The fan shaft shall be ground and polished solid steel mounted in heavy duty, permanently sealed, pillow block ball bearings. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.

F. Fan performance shall be based on tests conducted in accordance with AMCA 210. Fans shall be licensed to bear the AMCA Certified Ratings Seal for air performance.

2.7 KITCHEN HOOD UPBLAST ROOF EXHAUST FANS

A. General Description

1. Discharge air up and away from the mounting surface.

2. Upblast fan shall be for roof mounted applications.

3. Maximum continuous operating temperature is 400°F.

4. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Fan shall be direct-driven or belt-driven as indicated.

1. Fan Wheel

a. Type: Non-overloading, backward inclined centrifugal.

b. Material: Aluminum, statically and dynamically balanced in accordance to AMCA 204.

c. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

2. Housing

a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.

b. Rigid internal support structure.

c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.

d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.

e. Provide breather tube for fresh air motor cooling and wiring.

f. Provide an access opening on the curvature of the outer fan housing to allow for cleaning and inspection of the fan blades per NFPA 96. Access opening shall be a minimum 3 in. by 5 in. rectangular or minimum 4 in. diameter circular opening.

C. Shafts and Bearings

1. Fan Shaft

a. Ground and polished steel with anti-corrosive coating.

b. First critical speed at least 25 percent over maximum cataloged operating speed.

2. Bearings

a. Permanently sealed or pillow block type.

b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.

c. 100 percent factory tested.

D. Drive Assembly

1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.

2. Belts: Static free and oil resistant.

3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

4. The motor pulley shall be adjustable for final system balancing.

5. Readily accessible for maintenance.

E. Roof Curb: Minimum 12-inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, ventilated double wall, and factory installed nailer strip. Curb heights shall be increased as required to maintain a minimum height of 8 inches above adjacent roofing surface. Roof curb shall match roof slope so that the curb is level.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Accessories: The following accessories are required.

1. Birdscreen

a. Provide aluminum construction.

b. Protects fan discharge.

2. Roof Curb Extension: Provide vented curb extension per NFPA 96. Verify curb height with extension has a minimum of 40 inches clearance from the discharge lip of the fan to the finished roof.

3. Drain Connection:

a. Aluminum construction.

b. Allows single-point drainage of grease, water, or other residues.

4. Grease Trap:

a. Provide aluminum grease receptacle as required by NFPA 96.

b. Includes drain connection.

c. Collects grease residue.

5. Hinge Kit (factory Installed)

a. Aluminum hinges.

b. Hinges and restraint cables mounted to base (sleeve).

c. Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning.

6. Heat Baffle:

a. Provide 1-inch thick insulation shield that prevents heat from radiating into the motor compartment to meet requirements of UL 705 Supplement SC.

7. Variable Speed Control:

a. Provide an electronically commutated motor or a premium efficiency AC induction paired with a variable frequency drive capable of variable speed control for demand-based ventilation sequencing as required by the kitchen hood ventilation controls.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Refer to specification 23 02 00 – Part 1 for anchorage requirements for roof mounted equipment.

C. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer’s requirements.

D. Refer to 23 05 48 - Vibration Controls for HVAC Piping and Equipment for additional installation requirements.

E. Flexible duct connections and shutoff dampers are prohibited from being installed in duct systems conveying grease laden exhaust air per NFPA 96 requirements.

END OF SECTION

SECTION 23 36 13 - SERIES FAN-POWERED TERMINAL UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Series type fan-powered terminal unit.

1.2 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting, And Balancing

E. Section 23 08 00 - Commissioning of HVAC Systems

F. Section 23 09 63 - Energy Management and Control System (EMCS)

G. Section 23 31 13 - Metal Ductwork

H. Section 23 33 00 - Ductwork Accessories

I. Section 23 34 00 - HVAC Fans

J. Section 23 73 13 - Modular Indoor Central Station Air Handling Units

K. Section 23 81 19 - Self Contained Air Conditioners

1.3 REFERENCES

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).

C. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets; 2008, with Addendum (2011).

D. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

A. Terminal Units shall be AHRI 880 (I-P) certified and carry the AHRI Seal.

B. The terminal units shall be designed, built and tested as a single unit including fan motor and fan assembly, primary air damper assembly, water or electric heating coils and accessories.

C. The entire terminal unit and all electrical components shall be UL listed and installed in accordance with the NFPA 70.

1.5 GENERAL DESCRIPTIONS

A. Furnish, and install fan powered terminal units of the sizes and capacities shown on the plans.

B. Terminal Unit shall ship as a complete assembly requiring no field assembly (including accessories). Terminal unit manufacture shall factory mount EMCS controls, provided by Section 23 09 63 (EMCS contractor).

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01.

B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

C. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finished of materials.

D. Submit product data or filter media and filter performance data.

E. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

F. Submit manufacturer’s installation instructions under provisions of Division 01.

G. Submit operation and maintenance data under provisions of Section 23 02 00.

H. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

I. Terminal units shall include a QR code tag to link directly to the specific IOM for the terminal unit to be accessed by mobile device.

1.7 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled in accordance with the unit manufacturer’s instructions.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.9 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On-site demonstration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. TITUS

B. METALAIRE

C. KRUEGER

D. NAILOR INDUSTRIES

E. PRICE

2.2 TERMINAL CASING

A. The terminal casing shall be minimum 20 gauge galvanized steel, internally lined with 1" natural fiber or fiberglass free insulation which complies with UL 181 with regard to resistance to erosion and mold growth and NFPA 90A. Insulation shall have R-values of 4.0. Exposed fiberglass is not acceptable. The insulation shall be mechanically fastened to the unit casing. The fasteners shall be weld pins. Lining material glued in place without mechanical fasteners are not acceptable. Any exposed insulation edges shall be coated with NFPA 90A approved sealant, or covered with galvanized brackets or foil tape. The terminal shall have round duct collars for the primary air connections and a rectangular discharge suitable for flanged duct connection. The casing shall be provided with mounting brackets for hanging from structure.

B. The terminal casing shall have a bottom or side access panel, which allows removal of fan and servicing of terminal without disturbing duct connections.

C. The terminal casing shall have a filter rack/bracket for securing the air filter over the return air inlet. This filter rack shall be sized so that standard sized filters can be installed by the owner as part of ongoing maintenance.

2.3 FAN AND FAN MOTOR

A. The fan shall be constructed of steel and have a forward curved dynamically balanced wheel with direct drive motor.

B. The terminal unit shall utilize an ECM variable-speed DC brushless motors specifically designed for use with single phase, 277 volt, 60 hertz electrical input. Motor shall be complete and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator. All motors shall be designed for synchronous rotation. Rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in soft start and soft speed change ramps. Motor shall include integral thermal overload, locked rotor, and over-current protection. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motor shall be permanently lubricated with ball bearings. Motor shall be directly coupled to the blower. Motor shall maintain a minimum of 70 percent efficiency over its entire operating range. Provide a motor that is designed to overcome reverse rotation and not affect life expectancy.

C. The terminal unit manufacturer shall provide a factory-installed controller for digitally controlled automatic fan cfm adjustment. The remote PWM controller shall be capable of receiving a 0-10 Vdc signal from the DDC controller (provided by the controls contractor) to control the fan cfm.

2.4 CONTROL DAMPER

A. Cooling inlet shall have a damper assembly with factory set and calibrated pressure independent control. The damper shall be heavy gauge steel with shaft rotating in Delrin (Polyoxymethylene) self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent over-stroking and a synthetic seal to limit close-off leakage.

B. Damper and casing leakage shall be tested in accordance with ASHRAE Std 130 and shall not exceed 2% of rated airflow based on a nominal inlet velocity of 2000 fpm at 2.0 in.w.g. of static pressure.

C. Terminals with interior actuator linkage connection must include gasketed access panel, removable without disturbing ductwork.

2.5 HOT WATER HEATING COILS

A. Hot water heating coils shall be enclosed in a minimum 20 gauge galvanized steel casing with flanged construction for attachment to metal ductwork. Coils shall be factory installed on the terminal. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of 0.016”, with male solder header connections. Coils shall be leak tested to 500 psi, with an operating pressure of 360 psi and a minimum burst pressure of 2000 psi at ambient temperature. Number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with AHRI 410.

2.6 ELECTRIC HEATING COILS

A. Modulating electric coils shall be supplied and installed on the terminal unit by the manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3½ inches apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with a hinged access door for access to all controls and safety devices.

B. Electric coils shall contain a primary automatic reset thermal cutout, a secondary replaceable heat limiter per element, differential pressure airflow switch for proof of flow, and line terminal block. Coil shall include an integral door interlock type disconnect switch, which will not allow the access door to be opened while power is on. Non-interlocking type disconnects are not acceptable. All individual components shall be UL listed or recognized.

C. Heaters shall be equipped with modulating control (Lynergy Comfort Controller (LCC) or equal) to control heater coil firing. The control panel shall include an interface to control heater coil firing in proportion to the EMCS signal. The EMCS signal shall connect to low voltage universal signal interface circuitry supplied and installed by the terminal manufacturer. The universal interface shall be selected for either 0-10 VDC or 0-20 mA interface options, without additional interface circuitry.

2.7 FAN INTAKE FILTER

A. The filter shall be 1” thick, disposable construction type mounted in a rack on the fan air inlet and designed for ease of service.

B. Filter size shall be based on standard sizes that are readily available.

2.8 SOUND CRITERIA

A. Sound ratings for the terminals shall not exceed 40 NC in the occupied space at 1.0 inch w.g. inlet static pressure, and discharge static pressure of 0.25 inch w.g. NC estimations shall be calculated per AHRI 885, Appendix E. The terminal shall be provided with factory installed internal and external attenuators if sound requirements are not met. The external attenuator shall be shipped internal to the unit to protect it from shipping damage. The external attenuator shall be slid into the operation position and secured without the need for additional screws. Factory provided attenuators that require field installation are not acceptable.

2.9 CONTROLS AND SENSORS

A. The terminal shall mount the pressure independent electronic controls that are provided by Section 23 09 63.

B. The terminal unit shall incorporate a multi-point, center-averaging velocity sensor. A minimum of four measuring ports must be parallel to the takeoff point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03 in.w.g. at an inlet velocity of 500 fpm. The sensor must provide airflow control signal accuracy of ± 5%, with a hard 45° or 90° elbow attached directly to the inlet.

C. The terminal unit manufacturer shall provide, mount and wire fan relay, 24-volt transformer, and disconnect switch.

D. Flow measuring taps and flow curves shall be supplied with each terminal for field balancing airflow. Each terminal shall be equipped with labeling showing unit location, size, minimum and maximum cfm setpoints, damper fail position, QR code label as per submittal section, and thermostat action.

E. All electronic accessories, including switches for activation of fan shall be supplied and calibrated by the terminal manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Terminal units shall be installed with all required service clearances, according to manufacturer’s installation instructions.

B. Terminal units with electric heat shall be installed with clearance that meets NFPA 70.

C. All equipment shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.

D. Space limitation shall be reviewed carefully to ensure that all terminals will fit the available space.

E. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.

END OF SECTION

SECTION 23 36 19 - PARALLEL FAN-POWERED TERMINAL UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Parallel type fan-powered terminal unit.

1.2 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting, And Balancing

E. Section 23 08 00 - Commissioning of HVAC Systems

F. Section 23 09 63 - Energy Management and Control System (EMCS)

G. Section 23 31 13 - Metal Ductwork

H. Section 23 33 00 - Ductwork Accessories

I. Section 23 34 00 - HVAC Fans

J. Section 23 73 13 - Modular Indoor Central Station Air Handling Units

K. Section 23 81 19 - Self Contained Air Conditioners

1.3 REFERENCES

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).

C. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets; 2008, with Addendum (2011).

D. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

A. Terminal Units shall be AHRI 880 (I-P) certified and carry the AHRI Seal.

B. The terminal units shall be designed, built and tested as a single unit including fan motor and fan assembly, primary air damper assembly, water or electric heating coils and accessories.

C. The entire terminal unit and all electrical components shall be UL listed and installed in accordance with NFPA 70

1.5 GENERAL DESCRIPTIONS

A. Furnish, and install fan powered terminal units of the sizes and capacities shown on the plans.

B. Terminal Unit shall ship as a complete assembly requiring no field assembly (including accessories). Terminal unit manufacture shall factory mount EMCS controls, provided by Section 23 09 63 (EMCS Contractor).

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01.

B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

C. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finished of materials.

D. Submit product data or filter media and filter performance data.

E. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

F. Submit manufacturer’s installation instructions under provisions of Division 01.

G. Submit operation and maintenance data under provisions of Section 23 02 00.

H. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

I. Terminal units shall include a QR code tag to link directly to the specific IOM for the terminal unit to be accessed by mobile device.

1.7 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled in accordance with the unit manufacturer’s instructions.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.9 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On-site demonstration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. TITUS

B. METALAIRE

C. KRUEGER

D. NAILOR INDUSTRIES

E. PRICE

2.2 TERMINAL CASING

A. The terminal casing shall be minimum 20 gauge galvanized steel, internally lined with 1" natural fiber or fiberglass free insulation which complies with UL 181 with regard to resistance to erosion and mold growth and NFPA 90A. Insulation shall have R-values of 4.0. Exposed fiberglass is not acceptable. The insulation shall be mechanically fastened to the unit casing. The fasteners shall be weld pins. Lining material glued in place without mechanical fasteners are not acceptable. Any exposed insulation edges shall be coated with NFPA 90A approved sealant, or covered with galvanized brackets or foil tape. The terminal shall have round duct collars for the primary air connections and a rectangular discharge suitable for flanged duct connection. The casing shall be provided with mounting brackets for hanging from structure.

B. The terminal casing shall have a bottom or side access panel, which allows removal of fan and servicing of terminal without disturbing duct connections.

C. The terminal casing shall have a filter rack/bracket for securing the air filter over the return air inlet. This filter rack shall be sized so that standard sized filters can be installed by the owner as part of ongoing maintenance.

2.3 FAN AND FAN MOTOR

A. The fan shall be constructed of steel and have a forward curved dynamically balanced wheel with direct drive motor.

B. The terminal unit shall utilize an ECM variable-speed DC brushless motors specifically designed for use with single phase, 277 volt, 60 hertz electrical input. Motor shall be complete and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator. All motors shall be designed for synchronous rotation. Rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in soft start and soft speed change ramps. Motor shall include integral thermal overload, locked rotor, and over-current protection. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motor shall be permanently lubricated with ball bearings. Motor shall be directly coupled to the blower. Motor shall maintain a minimum of 70 percent efficiency over its entire operating range. Provide a motor that is designed to overcome reverse rotation and not affect life expectancy.

C. The terminal unit manufacturer shall provide a factory-installed controller for manual fan cfm adjustment. The manual PWM controller shall be field adjustable with a standard screwdriver. The factory shall preset the fan cfm as shown on the schedule.

2.4 CONTROL DAMPER

A. Cooling inlet shall have a damper assembly with factory set and calibrated pressure independent control. The damper shall be heavy gauge steel with shaft rotating in Delrin (Polyoxymethylene) self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent over-stroking and a synthetic seal to limit close-off leakage

B. Damper and casing leakage shall be tested in accordance with ASHRAE Std 130 and shall not exceed 2% of rated airflow based on a nominal inlet velocity of 2,000 fpm at 2.0 in.w.g. of static pressure.

C. Terminals with interior actuator linkage connection must include gasketed access panel, removable without disturbing ductwork

2.5 HOT WATER HEATING COILS

A. Hot water heating coils shall be enclosed in a minimum 20 gauge galvanized steel casing with flanged construction for attachment to metal ductwork. Coils shall be factory installed on the terminal. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of 0.016”, with male solder header connections. Coils shall be leak tested to 500 psi, with an operating pressure of 360 psi and a minimum burst pressure of 2000 psi at ambient temperature. Number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with AHRI 410.

2.6 ELECTRIC HEATING COILS

A. Modulating electric coils shall be supplied and installed on the terminal unit by the manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3½ inches apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with a hinged access door for access to all controls and safety devices.

B. Electric coils shall contain a primary automatic reset thermal cutout, a secondary replaceable heat limiter per element, differential pressure airflow switch for proof of flow, and line terminal block. Coil shall include an integral door interlock type disconnect switch, which will not allow the access door to be opened while power is on. Non-interlocking type disconnects are not acceptable. All individual components shall be UL listed or recognized.

C. Heaters shall be equipped with modulating control (Lynergy Comfort Controller (LCC) or equal) to control heater coil firing. The control panel shall include an interface to control heater coil firing in proportion to the EMCS signal. The EMCS signal shall connect to low voltage universal signal interface circuitry supplied and installed by the terminal manufacturer. The universal interface shall be selected for either 0-10 VDC or 0-20 mA interface options, without additional interface circuitry.

2.7 FAN INTAKE FILTER

A. The filter shall be 1” thick, disposable construction type mounted in a rack on the fan air inlet and designed for ease of service.

B. Filter size shall be based on standard sizes that are readily available.

2.8 SOUND CRITERIA

A. Sound ratings for the terminals shall not exceed 40 NC in the occupied space at 1.0 inch w.g. inlet static pressure, and discharge static pressure of 0.25 inch w.g. NC estimations shall be calculated per AHRI 885, Appendix E. The terminal shall be provided with factory installed internal and external attenuators if sound requirements are not met. The external attenuator shall be shipped internal to the unit to protect it from shipping damage. The external attenuator shall be slid into the operation position and secured without the need for additional screws. Factory provided attenuators that require field installation are not acceptable.

2.9 CONTROLS AND SENSORS

A. The terminal shall mount the pressure independent electronic controls that are provided by Section 23 09 63.

B. The terminal unit shall incorporate a multi-point, center-averaging velocity sensor. A minimum of four measuring ports must be parallel to the takeoff point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03 in.w.g. at an inlet velocity of 500 fpm. The sensor must provide airflow control signal accuracy of ± 5%, with a hard 45° or 90° elbow attached directly to the inlet.

C. The terminal unit manufacturer shall provide, mount and wire fan relay, 24-volt transformer, and disconnect switch.

D. Flow measuring taps and flow curves shall be supplied with each terminal for field balancing airflow. Each terminal shall be equipped with labeling showing unit location, size, minimum and maximum cfm setpoints, damper fail position, QR code label as per submittal section, and thermostat action.

E. All electronic accessories, including switches for activation of fan shall be supplied and calibrated by the terminal manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Terminal units shall be installed with all required service clearances, according to manufacturer’s installation instructions.

B. Terminal units with electric heat shall be installed with clearance that meets NFPA 70.

C. All equipment shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.

D. Space limitation shall be reviewed carefully to ensure that all terminals will fit the available space.

E. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.

END OF SECTION

SECTION 23 37 13 - AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Ceiling air diffusers.

B. Wall registers and grilles.

C. Louvers.

D. Other air devices indicated on drawings and schedules.

1.2 RELATED SECTIONS

A. Section 08 91 00 - Louvers

B. Section 23 02 00 - Basic Materials and Methods for HVAC

C. Section 23 05 93 - Testing, Adjusting, And Balancing

D. Section 23 07 13 - Duct Insulation

E. Section 23 31 13 - Metal Ductwork

F. Section 23 33 00 - Ductwork Accessories

1.3 REFERENCES

A. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).

B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2023.

C. AMCA 540 - Test Method for Louvers Impacted by Wind Borne Debris; 2013.

D. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2022.

E. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets; 2023.

F. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

G. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

I. ASTM D870 - Standard Practice for Testing Water Resistance of Coatings Using Water Immersion; 2015.

J. ASTM D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact); 1993 (Reapproved 2024).

K. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air distribution devices of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. AHRI Compliance: Test and rate air distribution devices in accordance with AHRI 880 (I-P).

2. ASHRAE Compliance: Test and rate air distribution devices in accordance with ASHRAE Std 70.

3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500-L.

4. AMCA 540 - Test Methods for Louvers Impacted by Wind Borne Debris with Enhanced Protection Approval.

5. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers.

6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

7. NFPA Compliance: Install air distribution devices in accordance with NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

9. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

10. IBC - International Building Code.

11. IMC - International Mechanical Code.

12. UMC - Uniform Mechanical Code.

1.5 DEFINITIONS

A. Hurricane-prone regions:

1. The U.S. Atlantic Ocean and Gulf of Mexico coasts where the ultimate design wind speed for Risk Category II Buildings is greater than 115 mph;

2. Hawaii, Puerto Rico, Guam, Virgin Islands and American Samoa.

B. Wind-borne debris region: Areas within hurricane-prone regions located:

1. Within 1 mile of the coastal mean high water line where the ultimate design wind speed is 130 mph or greater; or

2. In areas where the ultimate design wind speed is 140 mph or greater. For Risk Category II buildings and structures and Risk Category III building and structures, except health care facilities, the wind-borne debris region shall be based on Figure 1609.3(1). For Risk Category IV buildings and structures and Risk Category III health care facilities, the wind-borne debris region shall be based on Figure 1609.3(2).

C. Ultimate design wind speed - The ultimate design wind speed for the determination of the wind loads shall be determined by Figures 1609.3(1), 1609.3(2) and 1609.3(3) of ICC (IBC).

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for the following:

1. Air Distribution Devices

a. Schedule of air distribution devices indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

b. Data sheet for each type of air distribution devices, and accessory furnished; indicating construction, finish, and mounting details.

c. Performance data for each type of air distribution devices furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

2. Louvers

a. Manufacturer's product data including performance data.

b. Preparation instructions and recommendations.

c. Storage and handling requirements and recommendations.

d. Installation methods.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air distribution device and louver, indicating materials, construction, dimensions, accessories, and installation details.

C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver air distribution devices wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air distribution devices and louvers in original cartons and protect from weather and construction work traffic in accordance with manufacturer's instructions. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.8 WARRANTY

A. Warrant the installation of the work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from defective or nonconforming workmanship.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - AIR DEVICES

A. Titus Company

B. Metalaire Industries, Inc.

C. Nailor Industries

D. Krueger

E. Price

2.2 AIR DEVICES

A. Unless otherwise indicated, provide manufacturer's standard air devices when shown of size, shape, capacity, type and accessories indicated on drawings and schedules, constructed of materials and components as indicated and as required for complete installation and proper air distribution.

B. Provide air devices that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

C. Unless noted otherwise on drawings, the finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250-hour ASTM D870 Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50 inch-pound force applied.

D. Provide air device with border styles that are compatible with adjacent ceiling or wall system, and that are specially manufactured to fit into the wall construction or ceiling module with accurate fit and adequate support. Refer to architectural construction drawings and specifications for types of wall construction and ceiling systems.

E. Provide integral volume damper with roll formed steel blades where indicated on drawings or schedules. Dampers shall be opposed blade design with a screwdriver slot or a concealed lever operator for adjustment through the face of the air device.

F. Air devices designated for fire rated systems shall be pre-assembled with UL classified radiation damper and thermal blanket. Fire rated air devices shall be shipped completely assembled, one assembly per carton; each assembly shall be enclosed in plastic shrink wrap with installation instructions.

2.3 ACCEPTABLE MANUFACTURERS - LOUVERS

A. Ruskin Manufacturing Company

B. Greenheck Company

C. Louvers and Dampers, Inc.

D. Pottorff

E. Arrow

2.4 LOUVERS

A. Louvers not located in hurricane-prone regions or wind-borne debris regions shall meet the requirements of AMCA 500-L for Laboratory Methods of Testing Louvers for Rating and be drainable stationary type louvers.

B. Louvers located in hurricane-prone regions shall meet the requirements of AMCA 550 for High Velocity Wind Driven Rain without the use of a control damper.

C. Louvers located in wind-borne debris regions within 30 feet of grade shall meet the requirements of AMCA 540 for Large Missile Impact.

D. Provide louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

E. Provide louvers that have minimum free area and maximum pressure drop as indicated on drawings.

F. Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to architectural construction drawings and specifications for types of substrate.

G. Coordinate with Architect for finish and color.

H. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All interior surfaces of all air devices shall be painted flat black.

B. See floor plans for type, neck size and CFM of air for all air distribution devices.

C. Install all air distribution devices as detailed on plans and in accordance with manufacturer’s recommendations.

D. The backside of all air devices shall be insulated with taped and sealed external duct wrap to match the insulation thickness and R-value of the ductwork connecting to the air device. Refer to 23 07 13 - Duct Insulation.

E. Inspect areas to receive louvers. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.

F. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

G. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.

H. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

I. Touch-up, repair or replace any damaged products prior to substantial completion.

END OF SECTION

SECTION 23 41 00 - AIR FILTERS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC are included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

1.3 REFERENCES

A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.

B. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

PART 2 - PRODUCTS

2.1 FILTERS

A. Air filters shall be high efficiency ASHRAE pleated panels consisting of synthetic media, welded wire media support grid, and beverage board enclosing frame, AAF PREpleat M13, 2-inch thick or approved equal.

B. APPROVED MANUFACTURERS

1. American Air Filter.

2. Camfil.

3. Airguard Industries, Inc.

4. Cambridge.

5. Filtration Group

2.2 LOW VELOCITY FILTER SECTION

A. Filters shall be of the throwaway cartridge type in 2-inch frames. When installing multiple filters into slide-in frames tape adjacent filters together with duct tape to prevent bypassing of air around the filter. Media shall be rated at 500 feet per minute.

B. Filtering media shall be formed of non-woven reinforced synthetic type filtering media bonded to 96% open area media support grid folded into a non-creased radial pleat design. The filter pack shall be bonded to the enclosing frame to prevent air bypass. Minimum Efficiency Reporting Value of MERV 13 when evaluated under the guidelines of ASHRAE Std 52.2. Initial resistance shall not exceed 0.30 inches water gauge at 500 fpm face velocity.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Filters shall be provided upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to occupiable spaces per ASHRAE Std 62.1.

B. Install differential pressure switch to activate "Filter Dirty" light when pressure difference across filters reaches 0.5 inches w.g. (adjustable). Locate "filter dirty" lights in mechanical rooms with identifying label.

C. Refer to Section 23 02 00 for additional filter information.

END OF SECTION

SECTION 23 73 13 - MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Indoor central station air handling unit.

1.2 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping

C. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

D. Section 23 05 26 - Variable Frequency Motor Speed Control for HVAC Equipment

E. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

F. Section 23 07 13 - Duct Insulation

G. Section 23 31 13 - Metal Ductwork

H. Section 23 33 00 - Ductwork Accessories

I. Section 23 34 00 - HVAC Fans

J. Section 23 41 00 - Air Filters

1.3 REFERENCES

A. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment; 2011.

B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

C. AHRI 430 (I-P) - Standard for Performance Rating of Central Station Air-handling Unit Supply Fans; 2020.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

G. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

J. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NEMA MG 00001 - Motors and Generators; 2024.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.4 QUALITY ASSURANCE

A. Unit performance shall be certified in accordance with AHRI 430 (I-P) for central station air handling units.

B. Coil performance shall be certified in accordance with AHRI 410.

C. Direct-expansion coils shall be designed and tested in accordance with ASHRAE Std 15 Safety Code for Mechanical Refrigeration.

D. Insulation and insulation adhesive shall comply with NFPA 90A requirements or flame spread and smoke generation.

E. Unit shall be rated for sound performance in accordance with AHRI 260 and AMCA 300.

F. Unit shall be provided to comply with the maximum allowable fan horsepower per ICC (IECC) and ASHRAE Std 90.1 I-P.

1.5 GENERAL DESCRIPTION

A. Indoor mounted, central station air handling unit designed to provide air to a conditioned space as required to meet specified performance requirements for ventilation, heating, cooling, filtration, and distribution. Unit shall be assembled for horizontal/vertical application and arranged to discharge conditioned air as shown on the drawings. Units shall be supplied by the specified manufacturer.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division One.

B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

C. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.

D. Provide fan curves with specified operating point clearly plotted.

E. Submit product data of filter media, filter performance data, filter assembly, and filter frames.

F. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

G. Submit manufacturer's installation instructions under provisions of Division One.

H. Submit operation and maintenance data under provisions of Section 23 02 00.

I. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 WARRANTY

A. The air handling unit manufacturer shall warrant parts and labor for a period of eighteen (18) months from date of shipment, or twelve (12) months from date of start-up, whichever occurs first.

1.8 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled in accordance with the unit manufacturer's instructions.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, and fan has been test-run under observation.

1.10 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Trane

C. JCI

D. Daikin

E. Temtrol

2.2 GENERAL DESCRIPTION

A. Unit shall be factory supplied, central station air handler suitable for the capacities and configurations as shown on drawings. Unit may consist of a fan and coil section with a factory installed chilled water or direct-expansion coil, heating coil section, electric heat section, face and bypass section, filter section, access section, mixing box or combination filter-mixing box, return fan, diffuser, or air blender as indicated on the drawings.

B. All sections, whether assembled into a unit or supplied as separate components, shall have mating flanges for bolted assembly. The flange shall extend around the complete perimeter of each section. The manufacturer shall supply bolts and sufficient closed cell gasket for full perimeter coverage.

2.3 CASING

A. All unit sections shall be supplied with a formed galvanized steel perimeter base rail of at least 6 inches in height designed to support the weight and structural integrity of the unit. Condensate drain connection will not penetrate the base rail. If external isolators are not used, provide 6 inch minimum height housekeeping pads or sufficient overall height to provide p-trap with 1 inch greater that unit total static pressure.

B. Unit panels for all sections shall be double wall construction and shall be constructed of minimum 18 gauge G90 mill galvanized steel. Casing panels shall be fully removable for easy access to the unit, and shall be secured to structural frame with aluminized or cadmium plated screws. Removal of panels must not affect the structural integrity of the unit. All panels shall have a minimum of 2-inch thick foam insulation (R-13). All panels shall be completely gasketed prior to shipping.

C. Casing air leakage shall not exceed Leakage Class 6 per ASHRAE Std 111 at +/- 8” w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE Std 111 Leakage Class in the submittal. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8” w.g., whichever is less, and shall not exceed 0.0042” per inch of panel span (L/240). Floor panels shall be double-wall construction and designed to support a 300 lb. load during maintenance activities and shall deflect no more than 0.0042” per inch of panel span.

D. Double wall hinged removable access doors with multiple handles shall be provided in the fan, coil, and filter sections on the drive side of the unit. Access doors must also be provided in all sections where the removal of sheet metal screws is required for unit access. Doors shall be of the same thickness and construction as the wall panels. A gasket shall be provided around the entire door perimeter. Access sections shall be installed where indicated on the drawings and shall be double walled hinged door.

2.4 FANS

A. Units shall be provided with direct-driven, single-width, single-inlet (SWSI) airfoil plenum fans constructed per AMCA requirements for the duty specified. Class I fans are not acceptable. Fan wheels shall be aluminum construction and rated in accordance with and certified by AMCA 210. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Fans shall be selected such that the operating speed at peak design airflow conditions is not greater than 25% above the associated motor synchronous speed. Fans driven by motors operated by variable frequency drive shall not exceed the maximum fan RPM allowed by the manufacturer under a bypass condition. Each fan/motor assembly shall include a minimum 14 gauge spun steel fan inlet funnel, and a G90 galvanized steel motor support plate and fan base with 2" spring type vibration isolation. Provide horizontal spring type thrust restraints between the unit casing and each fan/motor assembly.

B. Units delivering supply airflow rates of significant magnitude shall be equipped with multiple supply fans in an array configuration. Refer to scheduled values to verify motor quantity per unit. Where multiple fans are provided, backdraft dampers shall be mounted upstream of each fan for isolation and a single source power motor control panel shall be factory installed. All fans shall be factory-wired to motor control panel which shall consist of individual motor overload relays and on-off disconnect switch for power isolation.

2.5 MOTORS

A. All motors shall be premium efficiency, totally enclosed fan-cooled (TEFC), selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG 00001 Part 30 and 31, section 4.4.2. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedules.

B. All fan motors shall be operated from variable frequency drives. Variable frequency drives shall be furnished, installed, and wired by the installing Contractor. Reference Section 23 05 26 - Variable Frequency Motor Speed Control for HVAC Equipment for additional VFD requirements. A factory inverter drive balance shall be performed on all air handling units to identify resonant frequencies. A report of the results shall be provided for unit startup purposes.

C. All motors operated by variable frequency drive shall be equipped with a maintenance free, conductive microfiber, shaft grounding ring with a minimum of two rows of circumferential microfibers to discharge electrical shaft currents within the motor and/or its bearings.

2.6 COILS

A. All coils shall be tested at 300 psig air pressure, under water.

B. All coils shall be installed on tracks for easy removal from the air handling unit. Units that require disassembly of the unit for coil removal are not acceptable.

C. Coils shall be aluminum plate fin type with belled collars and shall be bonded to 1/2 inch or 5/8 inch OD copper tubes by mechanical expansion. Coils shall have headers with steel MPT connections. Working pressure shall be 250 psig at 300°F.

D. All coil segments shall be furnished with 304 stainless steel coil casings and 304 stainless steel coil supports.

E. Coils shall be drainable and have non-trapping circuits. Headers shall have drain and vent connections extended to the outside of the unit casing. Supply and return headers shall be clearly labeled on the outside of the unit. Provide grommets at all pipe penetrations through cabinet.

F. Main drain pan shall be double wall stainless steel with minimum 2 inch insulation, sloped toward drain fitting, with integral elbow for side discharge and FPT connection, and shall comply with ASHRAE Std 62.1. A maximum of one drain shall be supplied for each cooling coil section which shall extend at least 18” downstream of the coil. The unit design shall not require a drain pan in any downstream section to contain the coil condensate. Moisture shall not carry over past the coil. Moisture eliminators are not acceptable for moisture carryover prevention.

G. Direct expansion coils shall be furnished with a brass distributor with solder type connections. Suction and discharge connections shall be on the same end regardless of row depth. Coils shall have intertwined circuits for equal operation on each circuit. Provide the number of distributors equal to the quantity of refrigerant circuits to the associated condensing unit. Direct expansion coil shall be selected to match the saturated suction temperature and capacity of the associated condensing unit.

1. Coils selected for use with A2L refrigerants shall be equipped with a factory refrigerant leak detection system. The leak detection system shall include a sufficient quantity of refrigerant detection sensors to detect leaks across the entire coil section. When the system detects a leak, the unit controller shall automatically initiate mitigation actions to prevent excessive refrigerant concentrations within occupied spaces.

2. Mitigation actions shall include, but are not limited to the following:

    a. Modulate the unit supply fan(s) to maximum speed.

    b. Disable compressor operation of the refrigerant circuit(s).

    c. Open all associated zone dampers and terminal box primary air dampers to 100% open.

    d. Disable all electric heat sources associated with the unit and any associated terminal boxes.

H. Maximum face velocity across cooling coils shall be 500 FPM, unless noted otherwise on equipment schedule.

I. Coils in series shall have a minimum of 14 inch access section between coil casings.

J. In units larger than 10,000 cfm, coils shall be removable through a service panel without disassembly of the unit.

2.7 FILTERS

A. Filter section shall accept 2 inch or 4 inch filters of standard sizes as indicated on drawings and shall be designed and constructed to house the type of filter specified. Section shall include side access slide rails.

B. A magnahelic differential pressure gauge shall be factory installed and flush mounted on drive side to measure the pressure drop across the filter.

C. A dirty filter allowance of 0.50” w.g. shall be incorporated into the total static pressure calculation of each air handling unit filter section.

D. Reference Section 23 41 00 - Air Filters for additional requirements.

2.8 MIXING BOXES AND INLET PLENUMS

A. Mixing boxes and inlet plenums shall be factory installed unless otherwise indicated on the Mechanical Drawings.

B. Field fabricated mixing boxes and sheet metal plenums shall be provided by the installing Contractor where indicated on the Mechanical Drawings. When field fabricated mixing boxes are provided, the installing Contractor and EMCS Contractor shall provide outside air and return air motorized control dampers and actuators.

C. Factory installed mixing boxes, economizer, and/or inlet plenums shall have factory mounted motorized control dampers. Dampers shall be opposed blades and interconnecting outside air, return air, and mixed air (if applicable) type. Installing EMCS Contractor shall furnish damper actuators. All factory installed mixing boxes shall have a double wall hinged access door on the drive side of the unit.

2.9 ACCESSORIES

A. All damper blades shall be galvanized steel, double skin airfoil type, housed in a galvanized steel frame and mechanically fastened to a hex axle rod rotating in stainless steel bearings. Dampers shall be sectionalized to limit blade length to no more than 48 inches so as to minimize blade warpage. Blade seals are required to assure tight closure. The damper shall be rated for a maximum leakage rate of 1 percent of nominal airflow at 1 inch w.g.

PART 3 - EXECUTION

3.1 INSTALLATION

A. If floor mounted air handling units are furnished with internal vibration isolation option, provide 2" thick Amber/Booth type NRC ribbed neoprene pads or approved equal to address high frequency breakout and provide additional unit elevation with overall sufficient height to provide p-trap with one inch greater than the unit total static pressure. Ribbed neoprene pads shall be located in accordance with the air handling unit manufacturer’s recommendations. Condensate drain connection shall not penetrate the base air handling unit’s rail.

B. Install in accordance with manufacturer's instructions.

C. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

D. Make electrical connections, taking care that these do not block access to any part of the equipment requiring service.

E. Unit wiring shall comply with NFPA 70 and all applicable UL standards.

F. Connect full size condensate drain pipe to air handling unit and extend to nearest drain.

G. Unit installation shall comply with NFPA 90A requirements.

H. System Startup Requirements: The installing Contractor service technician shall startup all air handling units. Technician shall at a minimum perform the following steps for each unit:

1. Energize the unit disconnect switch.

2. Verify correct voltage, phases and cycles.

3. Energize fan motor and verify correct direction of rotation.

4. Re-check damper operation: verify that unit cannot and will not operate with all dampers in the closed position.

5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.

6. Program unit VFD to skip or lockout resonant frequencies that were identified by the manufacturer's factory inverter drive balance to prevent the VFD from continuously operating at these frequencies.

I. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fans have been test run under observation.

J. The installing Contractor shall comply with manufacturer's start-up requirements to ensure safe and correct operation.

END OF SECTION

SECTION 23 73 16 - PACKAGED AIR HANDLING UNIT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Commercial packaged air handling unit.

1.2 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting, And Balancing

E. Section 23 07 13 - Duct Insulation

F. Section 23 31 13 - Metal Ductwork

G. Section 23 33 00 - Ductwork Accessories

H. Section 23 34 00 - HVAC Fans

I. Section 23 41 00 - Air Filters

1.3 REFERENCES

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2026.

B. AHRI 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment; 2019.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

D. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.4 QUALITY ASSURANCE

A. Unit performance shall be certified in accordance with AHRI 210/240 and AHRI 340/360.

B. Direct-expansion coils shall be designed and tested in accordance with ASHRAE Std 15 Safety Code for Mechanical Refrigeration.

C. Insulation and insulation adhesive shall comply with NFPA 90A requirements or flame spread and smoke generation.

1.5 GENERAL DESCRIPTION

A. Packaged air handling unit for use in commercial split systems designed to provide air to a conditioned space as required to meet specified performance requirements for ventilation, heating, cooling, filtration, and distribution. Unit shall be as shown on the drawings and shall be supplied by the specified manufacturer.

B. Unit with direct expansion coil shall be used in a refrigerant circuit with matching air cooled condensing unit. Unit with chilled water coil shall be used in chilled water circuit.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division One.

B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

C. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.

D. Provide fan curves with specified operating point clearly plotted.

E. Submit product data of filter media and filter performance data

F. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

G. Submit manufacturer’s installation instructions under provisions of Division One.

H. Submit operation and maintenance data.

I. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 WARRANTY

A. The air handling unit manufacturer shall warrant parts and labor for a period of eighteen (18) months from date of shipment, or twelve (12) months from date of start-up, whichever occurs first.

1.8 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled in accordance with the unit manufacturer’s instructions.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier: Model 40RF

B. Trane: Model TWE

C. JCI/York: Model NC/ND

D. Substitutions: Under provisions of Division One.

2.2 EQUIPMENT

A. Indoor mounted, draw-thru, packaged air handling unit that can be used in a suspended horizontal configuration or a vertical configuration. Unit shall consist of forward curved belt driven centrifugal fan(s), motor and drive assembly, prewired fan motor contactor, factory installed refrigerant metering devices (direct-expansion coil units), cooling coil, 2-in. disposable air filters, and condensate drain pans for vertical or horizontal configurations.

2.3 CASING

A. Cabinet shall be constructed of minimum 18 mill-galvanized steel.

B. Cabinet panels shall be fully insulated with 1/2 inch fire retardant material. Insulation shall contain an EPA-registered immobilized antimicrobial agent to effectively resist the growth of bacteria and fungi as proven by tests in accordance with ASTM G21.

C. Unit shall contain non-corrosive condensate drain pans for both vertical and horizontal applications. Drain pans shall have connections on right or left side of unit. Drain pans shall have the ability to be sloped toward the right or left side of the unit to prevent standing water from accumulating in pans.

2.4 FANS

A. Fans shall be double inlet, double width, forward curved, centrifugal type fan(s) with adjustable belt drive shall be standard. Thermal overload protection shall be standard on motor. Fan and motor bearings shall be permanently lubricated. Motor shall be of size as shown on equipment schedule and factory supplied and installed.

B. An alternate motor and/or high static drive shall be available to meet the airflow and external static pressure requirements specified on the equipment schedule.

2.5 EVAPORATOR COIL

A. Coils shall be arranged for draw-thru air flow and consist of a minimum 3 rows with aluminum fin surface mechanically bonded to 3/8” internally enhanced copper tubing.

B. Direct expansion coils will have single or dual refrigeration circuits. Each refrigeration circuit shall be controlled by factory installed thermal expansion valves (TXV) for refrigerant control. The TXV’s shall be capable of external adjustment.

C. Chilled water coil shall be pressure and leak tested at 300 psig.

2.6 FILTERS

A. Unit shall have factory supplied 2-inch throwaway type filters installed upstream from the cooling coil for construction period. Pleated filter shall be provided per Section 23 41 00 for permanent operation. Filter access shall be from either the right or left side of the unit.

2.7 ACCESSORIES

A. Hot Water Coil: Coil shall be 2-row, U-bend coil with copper tubes and aluminum plate fins bonded to the tubes by mechanical expansion. Coil shall be mounted in a galvanized steel housing that shall be fastened to the unit’s fan deck for blow-thru heating operation. Working pressure shall be 150 psig.

B. Steam Distributing Coil: Coil shall consist of one row of copper tubes with aluminum fins, and shall have inner steam distributing tubes. Coil shall be mounted in a galvanized steel housing and shall be fastened to the unit’s fan deck for blow-thru heating operation. Working pressure shall be 175 psig at 400°F.

C. Electric Heaters: Heaters shall be factory supplied for field installation as shown on the equipment drawings. Electric heat assembly shall be UL approved, and shall have single-point power wiring. Heater assembly shall include contactors with 24-v coils, power wiring, 24-v control wiring terminal blocks, and a hinged access panel. Electric heaters shall not be used with air discharge plenum.

D. Air Discharge Plenum: Plenum shall be factory supplied to provide free-blow air distribution for vertical floor mounted units. A grille with moveable vanes for horizontal or vertical airflow adjustment shall be included. Plenum shall be field assembled and field installed on the unit’s fan deck for blow-thru air distribution. Plenum shall not be used with electric heaters.

E. Return Air Grille: Grille shall be factory supplied for field installation on the unit's return air opening. Grille shall be satin finished aluminum with non adjustable louver.

F. Unit Subbase: Subbase assembly shall be factory supplied for field installation. Subbase shall elevate floor mounted vertical units to provide access for correct condensate drain connection.

G. Economizer: Economizer for ventilation or "free" cooling shall be factory provided for field installation. For free cooling applications, economizer shall be compatible with separate thermostat; economizer dampers shall open when outdoor air enthalpy is suitable for free cooling. Economizer shall be compatible with separate CO2 sensor accessory; economizer dampers shall open when indoor CO2 level rises above predetermined set point. Economizer shall include enthalpy control and damper actuator.

H. Refrigerant Leak Detection: Units provided with DX cooling coils shall be provided with factory installed leak detection system with sufficient quantity of refrigerant detection sensors to detect refrigerant leaks throughout the equipment cabinet. When the system detects a leak, the unit controller shall automatically initiate mitigation actions to prevent excessive refrigerant concentrations within occupied spaces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide refrigeration piping for single or dual refrigeration circuit and sizing as required by unit manufacturer.

C. Provide 18 gauge galvanized steel secondary drain pan, 3 inch larger on all sides with 2 inch lip and cross breaking, below all units installed above ceiling, in mechanical mezzanine, or in the attic space. The secondary drain pan shall be provided with a condensate overflow switch or separate drain line.

1. If a drain line is provided it shall be minimum of 3/4 inch and shall be routed to a visible location approved by the Architect. If this termination point is in a finished ceiling, provide escutcheon in trim and extend pipe to 1 inch below ceiling and paint to match ceiling color.

2. If a condensate overflow switch is provided, the overflow switch shall include the following features and adhere to the following installation and operation:

a. Condensate overflow switch features:

1) UL 508 listing

2) 24 volt power connection

3) Plenum rated casing and wiring when installed in a plenum used for return air

b. The condensate overflow switch shall be installed in the secondary drain pan and shall shut down the entire unit when the primary drain line becomes restricted. The switch shall be adjusted as required to ensure that the switch engages prior to the drain pan overflowing. At a minimum, unit shut down shall:

c. De-energize supply fan(s)

1) De-energize heater(s)

2) De-energize refrigeration circuit(s) for units with DX coils

3) Close chilled water valves for units with chilled water coils

4) Close heating hot water valves for units with hot water coils

5) Close outside air and economizer dampers

6) Generate an alarm locally at the unit and remotely through the EMCS

D. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

END OF SECTION

SECTION 23 73 26 - MODULAR OUTDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Outdoor central station air handling unit.

1.2 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 26 - Variable Frequency Motor Speed Control for HVAC Equipment

D. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

E. Section 23 07 13 - Duct Insulation

F. Section 23 31 13 - Metal Ductwork

G. Section 23 33 00 - Ductwork Accessories

H. Section 23 34 00 - HVAC Fans

I. Section 23 41 00 - Air Filters

1.3 REFERENCES

A. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment; 2011.

B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

C. AHRI 430 (I-P) - Standard for Performance Rating of Central Station Air-handling Unit Supply Fans; 2020.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

G. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

J. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

K. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces; 2025.

L. ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints; 2025.

M. ASTM D1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments; 2024.

N. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. NEMA MG 00001 - Motors and Generators; 2024.

P. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

Q. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.4 QUALITY ASSURANCE

A. Unit performance shall be certified in accordance with AHRI 430 (I-P) for central station air handling units.

B. Coil performance shall be certified in accordance with AHRI 410.

C. Direct-expansion coils shall be designed and tested in accordance with ASHRAE Std 15 Safety Code for Mechanical Refrigeration.

D. Insulation and insulation adhesive shall comply with NFPA 90A requirements or flame spread and smoke generation.

E. Unit shall be rated for sound performance in accordance with AHRI 260 and AMCA 300.

F. Unit shall be provided to comply with the maximum allowable fan horsepower per ICC (IECC) and ASHRAE Std 90.1 I-P.

1.5 GENERAL DESCRIPTION

A. Outdoor mounted, central station air handling unit designed to provide air to a conditioned space as required to meet specified performance requirements for ventilation, heating, cooling, filtration, and distribution. Unit shall be assembled for horizontal/vertical application and arranged to discharge conditioned air as shown on the drawings. Units shall be supplied by the specified manufacturer.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division One.

B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

C. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.

D. Provide fan curves with specified operating point clearly plotted.

E. Submit product data of filter media, filter performance data, filter assembly, and filter frames.

F. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

G. Submit manufacturer's installation instructions under provisions of Division One.

H. Submit operation and maintenance data under provisions of Section 23 02 00.

I. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

J. For roof mounted units provide delegated design submittal for equipment anchorage as required in specification 23 02 00 – Part 1.

1.7 WARRANTY

A. The air handling unit manufacturer shall warrant parts and labor for a period of eighteen (18) months from the date of shipment, or twelve (12) months from the date of start-up, whichever occurs first.

1.8 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled in accordance with the unit manufacturer's instructions.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, and fan has been test run under observation.

1.10 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Trane

C. JCI

D. Daikin

E. Temtrol

2.2 GENERAL DESCRIPTION

A. Unit shall be factory supplied, central station air handler suitable for the capacities and configurations as shown on drawings. Unit may consist of a fan and coil section with a factory installed chilled water or direct-expansion coil, heating coil section, electric heat section, face and bypass section, filter section, access section, mixing box or combination filter-mixing box, return fan, diffuser, or air blender as indicated on the drawings.

B. All sections, whether assembled into a unit or supplied as separate components, shall have mating flanges for bolted assembly. The flange shall extend around the complete perimeter of each section. The manufacturer shall supply bolts and sufficient closed cell gasket for full perimeter coverage.

2.3 CASING

A. All unit sections shall be supplied with a formed galvanized steel perimeter base rail of at least 6 inches in height designed to support the weight and structural integrity of the unit. Condensate drain connection shall not penetrate the base rail.

B. Unit panels for all sections shall be double wall construction and shall be constructed of minimum 18 gauge G90 mill galvanized steel. Casing panels shall be fully removable for easy access to the unit, and shall be secured to structural frame with aluminized or cadmium plated screws. Removal of panels must not affect the structural integrity of the unit. All panels shall have a minimum of 2-inch thick foam insulation (R-13). All panels shall be completely gasketed prior to shipping.

C. Manufacturer shall paint exterior surfaces of outdoor units prior to shipment.

1. Manufacturer shall apply a primer prior to application of finish coating.

2. Exterior finish coating shall show a breakdown of less than 1/8” on either side of a scribed line when subjected to ASTM B117 2,000 hour, 5% salt spray conditions. This is equivalent to an ASTM D1654 rating of '6'. Also, per ASTM D610, degree of rusting to meet #8-G and per ASTM D714 degree of blister to meet #6 medium.

D. Casing air leakage shall not exceed Leakage Class 6 per ASHRAE Std 111 at +/- 8” w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE Std 111 Leakage Class in the submittal. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8” w.g., whichever is less, and shall not exceed 0.0042” per inch of panel span (L/240). Floor panels shall be double-wall construction and designed to support a 300 lb. load during maintenance activities and shall deflect no more than 0.0042” per inch of panel span.

E. Double wall hinged removable access doors with a single ganged latch shall be provided in the fan, coil, and filter sections on the drive side of the unit. Access doors must also be provided in all sections where the removal of sheet metal screws is required for unit access. Doors shall be of the same thickness and construction as the wall panels. A gasket shall be provided around the entire door perimeter. Access sections shall be installed where indicated on the drawings and shall be double walled hinged door.

F. The roof shall be sloped with a minimum pitch of at least 1/8” per foot in at least one direction to prevent water from standing or pooling. It shall overhang the walls to prevent water from dripping into the door seams.

2.4 FANS

A. Units shall be provided with direct-driven, single-width, single-inlet (SWSI) airfoil plenum fans constructed per AMCA requirements for the duty specified. Class I fans are not acceptable. Fan wheels shall be aluminum construction and rated in accordance with and certified by AMCA 210. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan’s peak static pressure producing capability at the specified fan/motor speed. Fans shall be selected such that the operating speed at peak design airflow conditions is not greater than 25% above the associated motor synchronous speed. Fans driven by motors operated by variable frequency drive shall not exceed the maximum fan RPM allowed by the manufacturer under a bypass condition. Each fan/motor assembly shall include a minimum 14 gauge spun steel fan inlet funnel, and a G90 galvanized steel motor support plate and fan base with 2" spring type vibration isolation. Provide horizontal spring type thrust restraints between the unit casing and each fan/motor assembly.

B. Units delivering supply airflow rates of significant magnitude shall be equipped with multiple supply fans in an array configuration. Refer to scheduled values to verify motor quantity per unit. Where multiple fans are provided, backdraft dampers shall be mounted upstream of each fan for isolation and a single source power motor control panel shall be factory installed. All fans shall be factory-wired to motor control panel which shall consist of individual motor overload relays and on-off disconnect switch for power isolation.

2.5 MOTORS

A. All motors shall be premium efficiency, totally enclosed fan-cooled (TEFC), selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG 00001 Part 30 and 31, section 4.4.2. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedules.

B. All fan motors shall be operated from variable frequency drives. Variable frequency drives for outdoor air handling units shall be integral to the unit and shall be factory furnished, installed, and wired by the unit manufacturer. Reference Section 23 05 26 - Variable Frequency Motor Speed Control for HVAC Equipment for additional VFD requirements. A factory inverter drive balance shall be performed on all air handling units to identify resonant frequencies. A report of the results shall be provided for unit startup purposes.

C. All motors operated by variable frequency drive shall be equipped with a maintenance free, conductive microfiber, shaft grounding ring with a minimum of two rows of circumferential microfibers to discharge electrical shaft currents within the motor and/or its bearings.

2.6 COILS

A. All coils shall be tested at 300 psig air pressure, under water.

B. All coils shall be installed on tracks for easy removal from the air handling unit. Units that require disassembly of the unit for coil removal are not acceptable.

C. Coils shall be aluminum plate fin type with belled collars and shall be bonded to 1/2 inch or 5/8 inch OD copper tubes by mechanical expansion. Coils shall have headers with steel MPT connections. Working pressure shall be 250 psig at 300°F.

D. All coil segments shall be furnished with 304 stainless steel coil casings and 304 stainless steel coil supports.

E. Coils shall be drainable and have non-trapping circuits. Headers shall have drain and vent connections extended to the outside of the unit casing. Supply and return headers shall be clearly labeled on the outside of the unit. Provide grommets at all pipe penetrations through cabinet.

F. Main drain pan shall be double wall stainless steel with minimum 2 inch insulation, sloped toward drain fitting, with integral elbow for side discharge and FPT connection, and shall comply with ASHRAE Std 62.1. A maximum of one drain shall be supplied for each cooling coil section which shall extend at least 18” downstream of the coil. The unit design shall not require a drain pan in any downstream section to contain the coil condensate. Moisture shall not carry over past the coil. Moisture eliminators are not acceptable for moisture carryover prevention.

G. Direct expansion coils shall be furnished with a brass distributor with solder type connections. Suction and discharge connections shall be on the same end regardless of rows deep. Coils shall have intertwined circuits for equal operation on each circuit. Provide the number of distributors equal to the amount of refrigerant circuits to the associated condensing unit. Direct expansion coil shall be selected to match the saturated suction temperature and capacity of the associated condensing unit.

1. Coils selected for use with A2L refrigerants shall be equipped with a factory refrigerant leak detection system. The leak detection system shall include a sufficient quantity of refrigerant detection sensors to detect leaks across the entire coil section. When the system detects a leak, the unit controller shall automatically initiate mitigation actions to prevent excessive refrigerant concentrations within occupied spaces.

2. Mitigation actions shall include, but are not limited to the following:

a. Modulate the unit supply fan(s) to maximum speed.

b. Disable compressor operation of the refrigerant circuit(s).

c. Open all associated zone dampers and terminal box primary air dampers to 100% open.

d. Disable all electric heat sources associated with the unit and any associated terminal boxes.

H. Maximum face velocity across cooling coils shall be 500 FPM, unless noted otherwise on equipment schedule.

I. Coils in series shall have a minimum of 14 inch access section between coil casings.

J. In units larger than 10,000 cfm, coils shall be removable through a service panel without disassembly of the unit.

2.7 FILTERS

A. Filter section shall accept 2 inch or 4 inch filters of standard sizes as indicated on drawings and shall be designed and constructed to house the type of filter specified. Section shall include side access slide rails.

B. A magnahelic differential pressure gauge shall be factory installed and flush mounted on drive side to measure the pressure drop across the filter.

C. A dirty filter allowance of 0.50” w.g. shall be incorporated into the total static pressure calculation of each air handling unit filter section.

D. Reference Section 23 41 00 - Air Filters for additional requirements.

2.8 MIXING BOXES AND INLET PLENUMS

A. Factory installed mixing boxes, economizer, and/or inlet plenums shall have factory mounted motorized control dampers. Dampers shall be opposed blades and interconnecting outside air, return air, and mixed air (if applicable) type. Installing EMCS Contractor shall furnish damper actuators. All factory installed mixing boxes shall have a double wall hinged access door on the drive side of the unit.

B. Rain hoods shall be provided on outdoor unit air and economizer intakes, as shown on drawings. Provide rain hoods with bird screens.

C. Provide outdoor airflow measuring stations at outdoor air intakes. Outdoor airflow measuring stations shall be factory mounted and wired by the air handling unit manufacturer. The measuring station shall be located within the air handling unit as required to provide airflow accuracy as indicated in the manufacturer's performance data.

2.9 ROOF CURB

A. Provide a minimum 14" factory-fabricated galvanized steel roof curb. Curb height shall be increased as required to maintain a minimum height of 8 inches above adjacent roofing surface. Roof curb shall support the full-perimeter of the air handling equipment, including pipe chase cabinets where required.

B. Match roof curb to roof slope. Curb surface shall be level in both axes.

C. Provide wood nailing strip to which roofer may nail roof flashing.

D. Ship roof curb loose for field installation prior to unit placement.

E. Roof curb shall carry the stamp of a Licensed Professional Engineer to meet the wind load ratings at the jobsite conditions.

2.10 ACCESSORIES

A. All damper blades shall be galvanized steel, double skin airfoil type, housed in a galvanized steel frame and mechanically fastened to a hex axle rod rotating in stainless steel bearings. Dampers shall be sectionalized to limit blade length to no more than 48 inches so as to minimize blade warpage. Blade seals are required to assure tight closure. The damper shall be rated for a maximum leakage rate of 1 percent of nominal airflow at 1 inch w.g.

B. Provide unit with a condensate overflow switch installed in the primary drain pan. The overflow switch shall include the following features and adhere to the following installation and operation:

1. Condensate overflow switch features:

a. UL 508 listing

b. 24 volt power connection

2. The overflow switch shall shut down the entire unit when the primary drain line becomes restricted. The switch shall be adjusted as required to ensure that the switch engages prior to the drain pan overflowing. At a minimum, unit shut down shall:

    a. De-energize supply fan(s)

    b. Close chilled water valves for units with chilled water coils

    c. Close heating hot water valves for units with hot water coils

    d. De-energize heater(s)

    e. De-energize refrigeration circuit(s) for units with DX coils

    f. Close outside air and economizer dampers

    g. Generate an alarm locally at the unit and remotely through the EMCS

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Refer to specification 23 02 00 – Part 1 for anchorage requirements for roof mounted equipment.

C. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

D. Install the roof curb as required by the job conditions and as recommended by the manufacturer, and install proper flashing and counterflashing. See details on the Drawings.

E. Set the unit in place, taking care to protect the adjacent roofing, and make all ductwork connections.

F. Make electrical connections, taking care that these do not block access to any part of the equipment requiring service.

G. Unit wiring shall comply with NFPA 70 and all applicable UL standards.

H. Connect full size condensate drain pipe to air handling unit and extend to nearest drain.

I. Unit installation shall comply with NFPA 90A requirements.

J. System Startup Requirements: The installing Contractor service technician shall startup all air handling units. Technician shall at a minimum perform the following steps for each unit:

    1. Energize the unit disconnect switch.

    2. Verify correct voltage, phases and cycles.

3. Energize fan motor and verify correct direction of rotation.

4. Re-check damper operation: verify that unit cannot and will not operate with all dampers in the closed position.

5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.

6. Program unit VFD to skip or lockout resonant frequencies that were identified by the manufacturer's factory inverter drive balance to prevent the VFD from continuously operating at these frequencies.

K. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fans have been test run under observation.

L. The installing Contractor shall comply with manufacturer's start-up requirements to ensure safe and correct operation.

END OF SECTION

SECTION 23 74 16 - ROOFTOP HEATING AND COOLING UNITS (ELECTRIC COOLING - GAS HEATING)

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for Owner's use.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 09 63 - Energy Management and Control System (EMCS)

1.4 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 26 - Variable Frequency Motor Speed Control for HVAC Equipment

D. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

E. Section 23 05 93 - Testing, Adjusting, And Balancing

F. Section 23 33 00 - Ductwork Accessories

G. Section 23 41 00 - Air Filters

1.5 REFERENCES

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2026.

B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.

C. AHRI 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment; 2019.

D. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

F. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

G. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

H. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.6 QUALITY ASSURANCE

A. Unit shall be factory-charged and tested, shall be UL-labeled and certified by AHRI 210/240 or AHRI 340/360 and shall be AGA-certified.

B. Unit shall comply with ASHRAE Std 15.

C. Unit shall meet or exceed minimum efficiency requirements in accordance with ICC (IECC) and ASHRAE Std 90.1 I-P.

D. Unit shall be rated for sound performance in accordance with AHRI 270 (SI/I-P) and AMCA 300.

E. Coil performance shall be certified in accordance with AHRI 410.

F. Insulation and insulation adhesive shall comply with NFPA 90A requirements or flame spread and smoke generation.

1.7 SUBMITTALS

A. Submit Shop drawings and product data under provisions of Division One.

B. Shop drawings shall indicate components, dimensions, weights, required service clearances, and location and sizes of field connections. Indicate equipment, piping and connections and valves required for complete system.

C. Product data shall include rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

D. Provide fan curves with specified operating point clearly identified.

E. Submit manufacturer's installation instructions.

F. Provide delegated design submittal for equipment anchorage as required in specification 23 02 00 – Part 1.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation data.

B. Include start-up instructions, maintenance data, controls, and accessories. Include trouble-shooting guide.

C. Submit maintenance data.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site. Comply with manufacturer's installation instructions for rigging, unloading and transporting units.

B. Accept products on site and inspect for damage.

C. Protect units from physical damage. Factory shipping covers and skids shall be kept in place until installation. Store in a clean dry place and protect from weather and construction traffic.

1.10 WARRANTY

A. Provide a full parts and labor warranty by the equipment manufacturer for one year from start-up or 18 months from shipment, whichever occurs first.

B. Provide five-year warranty by the equipment manufacturer for compressors parts and labor.

1.11 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner’s operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

PART 2 - PRODUCTS

2.1 ROOFTOP UNITS

A. Rooftop unit shall be packaged and include electric cooling and gas-fired heat, with capacity and modulating cooling and heating as shown on the drawings.

B. Unit casing shall be heavy-gauge galvanized steel or heavy-gauge aluminum with protective coat of baked enamel. Weatherproof access panels shall be provided for access to all parts requiring service.

C. Compressor(s) shall be hermetic scroll type and shall be resiliently mounted to avoid vibration and noise. Compressor shall be provided with anti-slugging protection, crankcase heater, and time delay on recycling of the compressor. Two internal compressor motor thermal cutouts and a hot gas cutout shall protect the compressor in addition to high-pressure and low-pressure safeties. Standard controls shall permit operation down to 35 deg. F (2 deg. C), and compressor shall be locked out below this temperature.

D. Condenser fan(s) shall be direct-driven and shall be designed for operation exposed to the weather.

E. Condenser coils shall have a sub-cooling section.

F. Refrigerant circuit shall include filter dryer, moisture indicator, sight glass, gauge ports, full factory charge of R-454B or R-32 refrigerant and oil.

G. Filter rack shall be provided for filters 2 in. thick and shall filter both outdoor air and return air. See Section 23 41 00 - Air Filters for type of filters, and the number of filter changes to be furnished with the equipment.

H. Evaporator fan shall be quiet-type centrifugal blower, directly connected to an adjustable-speed motor or belt driven with an adjustable-pitch pulley on the motor.

I. Heat exchanger shall be aluminized steel, designed for long life and quiet operation. Burner shall provide dependable and quiet ignition in the stages as called for.

J. Gas burner controls shall provide automatic safety pilot, dual automatic gas valves, manual gas cock, and pressure regulator. Ignition shall be electric for the intermittent pilot with 100% shutoff when the unit is off.

K. Induced draft blower shall provide pre-purge and shall be provided with a proving switch to prevent burner operation if venter is not in operation.

L. Provide fan switch and limit control to delay the fan until heat is available and to continue fan operation until heat is dispersed. Limit switch shall shut the burner down in case of failure of operating controls.

M. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Std 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection.

2.2 ELECTRICAL

A. Unit wiring shall comply with NFPA 70 requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. Unit shall have a minimum short circuit current rating (SCCR) of 10,000 AIC. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

2.3 ACCESSORY EQUIPMENT

A. Unit shall be provided with hot gas reheat option for dehumidification. Hot gas reheat coil shall be located on the leaving air side of the evaporator coil and fully piped and circuited at the factory.

B. Provide integral metal hail guards for condenser coils. Hail guards shall cover all exposed faces of the condenser coil.

C. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Curb height shall be increased as required to maintain a minimum height of 8 inches above adjacent roofing surface. Gasket shall be provided for field mounting between the unit base and roof curb.

D. Provide economizer dampers and controls to provide "free cooling" from 0 to 100% outdoor air (OA) when the outside air humidity and temperature are acceptable. Provide OA, return air, and relief air dampers in a factory-provided enclosure. All air shall be filtered and bird screen shall be installed. Dampers shall have an air leakage rate not greater than 4 cfm/ft^2 of damper surface area at 1.0 in.w.g. and shall be labeled by an approved agency when tested in accordance with AMCA 500-D for such purpose.

E. A solid-state enthalpy changeover control shall determine the capability of the outside air to provide free cooling. The control package shall include a differential enthalpy sensor in the return air duct to compare the enthalpy of the outside air and return air and use the air with the lowest enthalpy for free cooling or assisting the mechanical cooling. The cooling control sequence is as follows:

1. The changeover control determines if the outdoor air is suitable for free cooling.

2. The space thermostat determines if cooling is needed in the building. If so,

3. The actuator modulates the outdoor air and return air dampers to maintain the desired mixed air temperature.

4. The second cooling stage of the space thermostat energizes the compressor to assist the economizer if required.

5. If the outdoor air is not suitable for free cooling, the outdoor air damper remains in the minimum ventilation position and the compressor is energized when space cooling is required.

F. Provide a warm-up thermostat to prevent the OA dampers from opening if the return air temperature is below the set point (65 deg. F) (18 deg. C).

G. Provide necessary controls for operation of the compressor below the normal temperature of the compressor cutout. Operation shall be permitted down to temperature specified on Drawings.

H. Provide factory-trained service person to check out the system, calibrate the controls, and see that the RTU is operating properly. The service person making the settings shall make a written report to the Engineer and the Owner with all set points listed for future reference.

I. Rooftop units mounted on slabs or other fixed locations shall be provided with adapters for end discharge and return to the unit.

J. Provide programmable combination thermostat/humidistat and other controls required to produce the control functions called for.

K. Manufacturer shall provide BACnet interface card for communication with EMCS.

L. Provide unit with factory installed refrigerant leak detection system with sufficient quantity of refrigerant detection sensors to detect refrigerant leaks throughout the equipment cabinet. When the system detects a leak, the unit controller shall automatically initiate mitigation actions to prevent excessive refrigerant concentrations within occupied spaces.

M. Provide unit with a condensate overflow switch installed in the primary drain pan. The overflow switch shall include the following features and adhere to the following installation and operation:

1. Condensate overflow switch features:

   a. UL 508 listing

   b. 24 volt power connection

2. The overflow switch shall shut down the entire unit when the primary drain line becomes restricted. The switch shall be adjusted as required to ensure that the switch engages prior to the drain pan overflowing. At a minimum, unit shut down shall:

   a. De-energize supply fan(s)

   b. De-energize heater(s)

c. De-energize refrigeration circuit(s)

d. Close outside air and economizer dampers

e. Generate an alarm locally at the unit and remotely through the EMCS

2.4 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Lennox

C. Trane

D. York

E. Aaon

F. Daikin

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the curb as required by the job conditions and as recommended by the manufacturer, and install proper flashing and counterflashing. See details on the Drawings.

B. Refer to specification 23 02 00 - Part 1 for anchorage requirements for roof mounted equipment.

C. Set the unit in place, taking care to protect the adjacent roofing, and connect the supply and return ductwork.

D. Make electrical and gas line connections, taking care that these do not block access to any part of the equipment requiring service.

E. Unit wiring shall comply with NFPA 70 and all applicable UL standards.

F. Connect full size condensate drain pipe to roof top unit and extend to nearest drain.

G. Unit installation shall comply with NFPA 90A requirements.

3.2 MANUFACTURER START-UP SERVICES

A. Provide authorized representative of the manufacturer to inspect the assembly and installation of each unit. Perform no start-up, tests, or adjustments on a unit until the representative determines that the unit has been properly assembled and installed.

B. The representative shall start-up, test, and adjust units. The representative shall perform operational checks to make certain that all equipment and controls of the systems are operating properly. If defects or improper adjustments are found, they shall be corrected and tests repeated.

C. The representative shall prepare and provide a written start-up report to include any measurements taken, test results obtained, or corrective actions required.

D. In addition to start-up, the manufacturer's representative shall attend a separate meeting on-site with the EMCS contractor to coordinate and execute programming between the packaged equipment controls and the EMCS.

3.3 BALANCING AND TEST

A. Operate the roof top unit and check for proper supply air quantity, noise, and proper operation.

B. Report the airflow, static pressure, voltage and current draw of each item, refrigerant pressure readings, etc., as required by Section 23 05 93 - Testing, Adjusting, And Balancing. This system is not complete until these readings have been made, submitted to the engineer, and accepted.

END OF SECTION

SECTION 23 74 19 - ROOFTOP HEATING AND COOLING UNITS (ELECTRIC COOLING - ELECTRIC HEAT)

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as a part of this Section as though written in full in this document.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 09 63 - Energy Management and Control System (EMCS)

1.4 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 26 - Variable Frequency Motor Speed Control for HVAC Equipment

D. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

E. Section 23 05 93 - Testing, Adjusting, And Balancing

F. Section 23 33 00 - Ductwork Accessories

G. Section 23 41 00 - Air Filters

1.5 REFERENCES

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2026.

B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.

C. AHRI 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment; 2019.

D. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

F. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

G. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

H. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

M. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.

1.6 QUALITY ASSURANCE

A. Unit shall be factory-charged and tested, shall be UL-labeled and certified by AHRI 210/240 or AHRI 340/360.

B. Unit shall comply with ASHRAE Std 15.

C. Unit shall meet or exceed minimum efficiency requirements in accordance with ICC (IECC) and ASHRAE Std 90.1 I-P.

D. Unit shall be rated for sound performance in accordance with AHRI 270 (SI/I-P) and AMCA 300.

E. Coil performance shall be certified in accordance with AHRI 410.

F. Insulation and insulation adhesive shall comply with NFPA 90A requirements or flame spread and smoke generation.

1.7 SUBMITTALS

A. Submit Shop drawings and product data under provisions of Division One.

B. Shop drawings shall indicate components, dimensions, weights, required service clearances, and location and sizes of field connections. Indicate equipment, piping and connections and valves required for complete system.

C. Product data shall include rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

D. Provide fan curves with specified operating point clearly identified.

E. Submit manufacturer's installation instructions.

F. Provide delegated design submittal for equipment anchorage as required in specification 23 02 00 - Part 1.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation data.

B. Include start-up instructions, maintenance data, controls, and accessories. Include trouble-shooting guide.

C. Submit maintenance data.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site. Comply with manufacturer's installation instructions for rigging, unloading and transporting units.

B. Accept products on site and inspect for damage.

C. Protect units from physical damage. Factory shipping covers and skids shall be kept in place until installation. Store in a clean dry place and protect from weather and construction traffic.

1.10 WARRANTY

A. Provide a full parts and labor warranty by the equipment manufacturer for one year from start-up or 18 months from shipment, whichever occurs first.

B. Provide five-year warranty by equipment manufacturer for compressors parts and labor.

1.11 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner’s operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

PART 2 - PRODUCTS

2.1 ROOFTOP UNIT

A. Rooftop unit shall be packaged and include electric cooling and electric heat with capacity and modulating cooling and heating as shown on the drawings.

B. Unit shall be factory-charged and tested, shall be UL-labeled, AHRI 210/240 and AHRI 270 (SI/I-P) certified, and shall be AGA-certified.

C. Unit casing shall be heavy-gauge galvanized steel or heavy-gauge aluminum with protective coat of baked enamel. Weatherproof access panels shall be provided for access to all parts requiring service.

D. Compressor(s) shall be hermetic scroll type and shall be resiliently mounted to avoid vibration and noise. Compressor shall be provided with anti-slugging protection, crankcase heater, and time delay on recycling of the compressor. Two internal compressor motor thermal cutouts and a hot gas cutout shall protect the compressor in addition to high-pressure and low-pressure safeties. Standard controls shall permit operation down to 35 deg. F (2 deg. C) and compressor shall be locked out below this temperature.

E. Condenser fan(s) shall be direct-driven on the shaft of the slow-speed motor, which shall be designed to operate exposed to the weather.

F. Condenser coils shall have a sub-cooling section.

G. Refrigerant circuit shall include filter dryer, moisture indicator, sight glass, gauge ports, full factory charge of R-454B or R-32 refrigerant and oil.

H. Filter rack shall be provided for filters 2 in. thick and shall filter both outdoor air and return air. See Section 23 41 00 - Air Filters for type of filters and the number of filter changes to be furnished with the equipment.

I. Evaporator fan shall be quiet-type centrifugal blower, directly connected to an adjustable-speed motor or belt driven with an adjustable-pitch pulley on the motor.

J. Electric heat section shall be installed in the unit and served by the same power source as the rest of the unit. Only one power feed shall be required for the unit.

K. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Std 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection.

2.2 ELECTRICAL

A. Unit wiring shall comply with NFPA 70 requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. Unit shall have a minimum short circuit current rating (SCCR) of 10,000 AIC. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

2.3 ACCESSORY EQUIPMENT

A. Unit shall be provided with hot gas reheat option for dehumidification. Hot gas reheat coil shall be located on the leaving air side of the evaporator coil and fully piped and circuited at the factory.

B. Provide integral metal hail guards for condenser coils. Hail guards shall cover all exposed faces of the condenser coil.

C. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Curb height shall be increased as required to maintain a minimum height of 8 inches above adjacent roofing surface. Gasket shall be provided for field mounting between the unit base and roof curb.

D. Provide "power saver" dampers and controls to provide "free cooling" from 0 to 100% outdoor air (OA) when the outside air humidity and temperature are acceptable. Provide OA, return air, and relief air dampers in a factory-provided enclosure. All air shall be filtered and bird screen shall be installed. Dampers shall have an air leakage rate not greater than 4 cfm/ft^2 of damper surface area at 1.0 in.w.g. and shall be labeled by an approved agency when tested in accordance with AMCA 500-D for such purpose.

E. A solid-state enthalpy changeover control shall determine the capability of the outside air to provide free cooling. The control package shall include a differential enthalpy sensor in the return air duct to compare the enthalpy of the outside air and return air and use the air with the lowest enthalpy for free cooling or assisting the mechanical cooling. The cooling control sequence is as follows:

1. The changeover control determines if the outdoor air is suitable for free cooling.

2. The space thermostat determines if cooling is needed in the building. If so:

3. The actuator modulates the outdoor air and return air dampers to maintain the desired mixed air temperature.

4. The second cooling stage of the space thermostat energizes the compressor to assist the economizer if required.

5. If the outdoor air is not suitable for free cooling, the outdoor air damper remains in the minimum ventilation position and the compressor is energized when space cooling is required.

F. Provide a warm-up thermostat to prevent the OA dampers from opening if the return air temperature is below the set point (65 deg. F) (18 deg. C).

G. Provide necessary controls for operation of the compressor below the normal temperature of the compressor cutout. Operation shall be permitted down to temperature specified on drawings.

H. Provide factory-trained service person to check out the system, calibrate the controls, and see that the RTU is operating properly. The service person making the settings shall make a written report to the engineer and the owner with all set points listed for future reference.

I. Rooftop units mounted on slabs or other fixed locations shall be provided with adapters for end discharge and return to the unit.

J. Provide programmable combination thermostat/humidistat and other controls required to produce the control functions called for.

K. Manufacturer shall provide BACnet interface card for communication with EMCS.

L. Provide unit with factory installed refrigerant leak detection system with sufficient quantity of refrigerant detection sensors to detect refrigerant leaks throughout the equipment cabinet. When the system detects a leak, the unit controller shall automatically initiate mitigation actions to prevent excessive refrigerant concentrations within occupied spaces.

M. Provide unit with a condensate overflow switch installed in the primary drain pan. The overflow switch shall include the following features and adhere to the following installation and operation:

1. Condensate overflow switch features:

   a. UL 508 listing

   b. 24 volt power connection

2. The overflow switch shall shut down the entire unit when the primary drain line becomes restricted. The switch shall be adjusted as required to ensure that the switch engages prior to the drain pan overflowing. At a minimum, unit shut down shall:

   a. De-energize supply fan(s)

   b. De-energize heater(s)

c. De-energize refrigeration circuit(s)

d. Close outside air and economizer dampers

e. Generate an alarm locally at the unit and remotely through the EMCS

2.4 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Lennox

C. Trane

D. York

E. Aaon

F. Daikin

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the curb as required by the job conditions and as recommended by the manufacturer, and install proper flashing and counterflashing. See details on the drawings.

B. Refer to specification 23 02 00 - Part 1 for anchorage requirements for roof mounted equipment.

C. Set the unit in place, taking care to protect the adjacent roofing, and connect the supply and return ductwork.

D. Make electrical connections, taking care that these do not block access to any part of the equipment requiring service.

E. Unit wiring shall comply with NFPA 70 and all applicable UL standards.

F. Connect full size condensate drain pipe to roof top unit and extend to nearest drain.

G. Unit installation shall comply with NFPA 90A requirements.

3.2 MANUFACTURER START-UP SERVICES

A. Provide authorized representative of the manufacturer to inspect the assembly and installation of each unit. Perform no start-up, tests, or adjustments on a unit until the representative determines that the unit has been properly assembled and installed.

B. The representative shall start-up, test, and adjust units. The representative shall perform operational checks to make certain that all equipment and controls of the systems are operating properly. If defects or improper adjustments are found, they shall be corrected and tests repeated.

C. The representative shall prepare and provide a written start-up report to include any measurements taken, test results obtained, or corrective actions required.

D. In addition to start-up, the manufacturer's representative shall attend a separate meeting on-site with the EMCS contractor to coordinate and execute programming between the packaged equipment controls and the EMCS.

3.3 BALANCING AND TEST

A. Operate the roof top unit and check for proper supply air quantity, noise, and proper operation.

B. Report the airflow, static pressure, voltage and current draw of each item, refrigerant pressure readings, etc., as required by Section 23 05 93 - Testing, Adjusting, And Balancing. This system is not complete until these readings have been made, submitted to the engineer, and accepted.

END OF SECTION

SECTION 23 74 21 - VARIABLE AIR VOLUME ROOFTOP UNITS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the general conditions and supplementary conditions apply to all work herein.

B. Section 23 02 00 - Basic Materials and Methods for HVAC shall be included as part of this section as though written in full in this document.

1.2 WORK INCLUDED

A. Commercial packaged rooftop air conditioners.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 09 63 - Energy Management and Control System (EMCS)

1.4 RELATED SECTIONS

A. Section 23 02 00 - Basic Materials and Methods for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 26 - Variable Frequency Motor Speed Control for HVAC Equipment

D. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment

E. Section 23 05 93 - Testing, Adjusting, And Balancing

F. Section 23 33 00 - Ductwork Accessories

G. Section 23 41 00 - Air Filters

1.5 REFERENCES

A. AHRI 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment; 2019.

B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).

C. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

D. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

E. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Addendum (2026).

F. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

I. ICC (IECC) - International Energy Conservation Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

L. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

1.6 QUALITY ASSURANCE

A. Unit construction shall comply with ASHRAE Std 15 - Safety Code for Mechanical Refrigeration.

B. Unit shall meet or exceed minimum efficiency requirements in accordance with ICC (IECC) and ASHRAE Std 90.1 I-P per testing standards prescribed by AHRI 340/360 - Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard.

C. All coils shall be constructed to meet the requirements of AHRI 410 - Forced Circulation Air-Cooling and Air- Heating Coils.

D. ANSI/UL 465 - Central Cooling Air Conditioners Standard for safety requirements.

E. Unit shall be rated for sound performance in accordance with AMCA 300 - Reverberant room method for sound testing of fans.

F. ANSI S1.32 - Precision methods for the determination of sound power levels of discrete frequency and narrow band noise sources in reverberation rooms.

1.7 SUBMITTALS

A. Submit Shop drawings and product data under provisions of Division One.

B. Shop drawings shall indicate components, dimensions, weights, required service clearances, and location and sizes of field connections. Indicate equipment, piping and connections and valves required for complete system.

C. Product data shall include rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

D. Provide fan curves with specified operating point clearly identified.

E. Submit manufacturer's installation instructions.

F. Provide delegated design submittal for equipment anchorage as required in specification 23 02 00 – Part 1.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation data.

B. Include start-up instructions, maintenance data, controls, and accessories. Include trouble-shooting guide.

C. Submit maintenance data.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site. Comply with manufacturer's installation instructions for rigging, unloading and transporting units.

B. Accept products on site and inspect for damage.

C. Protect units from physical damage. Factory shipping covers and skids shall be kept in place until installation. Store in a clean dry place and protect from weather and construction traffic.

1.10 WARRANTY

A. Provide a full parts and labor warranty by the equipment manufacturer for one year from start-up or 18 months from shipment, whichever occurs first.

B. Provide five-year warranty by the equipment manufacturer for compressors parts and labor.

1.11 OPERATIONS PERSONNEL TRAINING

A. Provide a training session for the owner’s operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Daikin

B. Trane

C. Carrier

D. York

E. Aaon

2.2 CABINET, CASING, AND FRAME

A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

B. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

C. Service doors shall be provided on the fan section, filter section, economizer section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.3 FAN POWERED ECONOMIZER SECTION

A. Unit shall be provided with a fan powered outdoor air economizer section. The fan of the economizer section shall operate as a system return fan. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow supplemental cooling if needed to maintain the cooling discharge air temperature. The outdoor air and exhaust air hoods shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hoods shall include moisture eliminator filters to drain water away from the entering air stream. The outside, return, and exhaust air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1” differential pressure in according with testing defined in AMCA 500-D. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. The unit packaged controls shall enable the economizer whenever the outside air enthalpy is less than 28.0 BTU/lb., the outside air dry bulb temperature is less than 75°F, and the space temperature sensor calls for cooling.

B. Exhaust fan shall be single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

C. The fan motor shall be a totally enclosed motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor in the case of excessive motor protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

D. The unit controller shall operate the exhaust fan to maintain a fixed CFM offset between outside air and exhaust air of 10% (Adj.) positive pressure to the space.

2.4 FILTERS

A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2” prefilter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2” MERV-8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

2.5 COOLING COIL

A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE Std 62.1 compliant double sloped drain pan.

B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Std 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.6 SUPPLY FAN

A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable.

B. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.

C. Supply fan and motor assembly combinations larger than 8 hp or 22” diameter shall be internally isolated on 1” deflection, spring isolators and include removable shipping tie downs.

D. The fan motor shall be a totally enclosed motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

E. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.7 VARIABLE AIR VOLUME CONTROL

A. The unit controller shall increase/decrease the speed of the supply fan in order to maintain the associated duct static pressure within its setpoint. The unit controller shall provide discharge air temperature control with the compressor modulation.

2.8 CONDENSING SECTION

A. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.

B. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0~120°F. Mechanical cooling shall be provided to 25º F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

C. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.

D. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.

E. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.

F. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.

G. Each circuit shall be dehydrated and factory charged with R-454B or R-32 Refrigerant and oil.

H. Provide integral metal hail guards for condenser coils. Hail guards shall cover all exposed faces of the condenser coil.

2.9 ELECTRICAL

A. Unit wiring shall comply with NFPA 70 requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. Unit shall have a minimum short circuit current rating (SCCR) of 65,000 AIC. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

2.10 CONTROLS

A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.

B. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.

C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.

E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via EMCS network communications. Manufacturer shall provide BACnet interface card for integration with EMCS.

F. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

1. Return air temperature.
2. Discharge air temperature.
3. Outdoor air temperature.
4. Space air temperature.
5. Outdoor enthalpy, high/low.
6. Compressor suction temperature and pressure
7. Compressor head pressure and temperature
8. Expansion valve position
9. Condenser fan speed
10. Inverter compressor speed

11. Dirty filter indication.
12. Airflow verification.
13. Cooling status.
14. Control temperature (Changeover).
15. VAV box output status.
16. Cooling status/capacity.
17. Unit status.
18. All time schedules.
19. Active alarms with time and date.
20. Previous alarms with time and date.
21. Optimal start
22. Supply fan and exhaust fan speed.
23. System operating hours.
    a. Fan
    b. Exhaust fan
    c. Cooling
    d. Individual compressor
    e. Heating
    f. Economizer
    g. Tenant override

G. The user interaction with the keypad shall provide the following:

1. Controls mode
    a. Off manual
    b. Auto
    c. Heat/Cool
    d. Cool only
    e. Heat only
    f. Fan only

2. Occupancy mode
    a. Auto
    b. Occupied
    c. Unoccupied
    d. Tenant override
3. Unit operation changeover control
    a. Return air temperature
    b. Space temperature
    c. Network signal
4. Cooling and heating change-over temperature with deadband
5. Cooling discharge air temperature (DAT)
6. Supply reset options
    a. Return air temperature
    b. Outdoor air temperature
    c. Space temperature
    d. Airflow (VAV)
    e. Network signal
    f. External (0-10 vdc)
    g. External (0-20 mA)
7. Temperature alarm limits
    a. High supply air temperature
    b. Low supply air temperature
    c. High return air temperature
8. Lockout control for compressors.
9. Compressor interstage timers
10. Night setback and setup space temperature.
11. Building static pressure.
12. Economizer changeover

a. Enthalpy

b. Drybulb temperature

13. Currently time and date

14. Tenant override time

15. Occupied/unoccupied time schedule

16. One event schedule

17. Holiday dates and duration

18. Adjustable set points

19. Service mode

a. Timers normal (all time delays normal)

b. Timers fast (all time delays 20 sec)

H. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:

1. Zone sensor with tenant override switch

2. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)

I. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:

1. Airflow

2. Outside air temperature

3. Space temperature

4. Return air temperature

5. External signal of 1-5 vdc

6. External signal of 0-20 mA

7. Network signal

2.11 ROOF CURB

A. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Curb height shall be increased as required to maintain a minimum height of 8 inches above adjacent roofing surface. Gasket shall be provided for field mounting between the unit base and roof curb.

2.12 REFRIGERANT LEAK DETECTION

A. Provide unit with factory installed refrigerant leak detection system with sufficient quantity of refrigerant detection sensors to detect refrigerant leaks throughout the equipment cabinet.

B. When the system detects a leak, the unit controller shall automatically initiate mitigation actions to prevent excessive refrigerant concentrations within occupied spaces.

2.13 CONDENSATE OVERFLOW SWITCH

A. Provide unit with a condensate overflow switch installed in the primary drain pan. The overflow switch shall include the following features and adhere to the following installation and operation:

1. Condensate overflow switch features:

a. UL 508 listing

b. 24 volt power connection

2. The overflow switch shall shut down the entire unit when the primary drain line becomes restricted. The switch shall be adjusted as required to ensure that the switch engages prior to the drain pan overflowing. At a minimum, unit shut down shall:

a. De-energize supply fan(s)

b. De-energize exhaust/relief fan(s)

c. De-energize heater(s)

d. De-energize refrigeration circuit(s)

e. Close outside air, relief air, and economizer dampers

f. Generate an alarm locally at the unit and remotely through the EMCS

PART 3 - EXECUTION

3.1 INSTALLATION

A. Handle, rig and install the unit in accordance with manufacturer's installation instructions.

B. Refer to specification 23 02 00 – Part 1 for anchorage requirements for roof mounted equipment.

C. Provide for single point main unit power connection to electrical service. All electrical work performed in the installation of the system as described in this specification shall be per NFPA 70 (NEC) and per applicable state and local codes.

D. Install unit and all filed mounted accessories to comply with NFPA 90A and NFPA 90B.

E. Pipe drain pan condensate with appropriately sized P-trap.

F. Provide ductwork connections to unit with flexible duct connectors.

3.2 MANUFACTURER START-UP SERVICES

A. Provide authorized representative of the manufacturer to inspect the assembly and installation of each unit. Perform no start-up, tests, or adjustments on a unit until the representative determines that the unit has been properly assembled and installed.

B. The representative shall start-up, test, and adjust units. The representative shall perform operational checks to make certain that all equipment and controls of the systems are operating properly. If defects or improper adjustments are found, they shall be corrected and tests repeated.

C. The representative shall prepare and provide a written start-up report to include any measurements taken, test results obtained, or corrective actions required.

D. In addition to start-up, the manufacturer's representative shall attend a separate meeting on-site with the EMCS contractor to coordinate and execute programming between the packaged equipment controls and the EMCS.

END OF SECTION

SECTION 26 02 00 - BASIC MATERIALS AND METHODS FOR ELECTRICAL

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all Work herein.

B. The Contract Drawings indicate the extent and general arrangement of the systems. If any departure from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted to the Architect for approval as soon as practicable. No such departures shall be made without the prior written approval of the Architect.

1.2 SCOPE OF WORK

A. The Work included under this Contract consists of the furnishing and installation of all equipment and material necessary and required to form the complete and functioning systems in all of its various phases, all as shown on the accompanying Drawings and/or described in these Specifications. The contractor shall review all pertinent drawings, including those of other contracts prior to commencement of Work.

B. This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.

C. The approximate locations of Electrical items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the Review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.

D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

E. Any discrepancies within the Contract Documents or between the Contract Documents and actual job-site conditions shall be reported to the Owner or Engineer so that they will be resolved prior to bidding. Where this cannot be done at least seven (7) working days prior to bid, the greater or more costly of the discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.

F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.

G. It is the intent of the above "Scope" to give the Contractor a general outline of the extent of the Work involved; however, it is not intended to include each and every item required for the Work. Anything omitted from the "Scope" but shown on the Drawings, or specified later, or necessary for a complete and functioning electrical system shall be considered a part of the overall "Scope".

H. The Contractor shall rough-in fixtures and equipment furnished by others from rough-in and placement drawings furnished by others. The Contractor shall make final connection to fixtures and equipment furnished by others.

I. Contractor shall participate in the commissioning process; including but not limited to meeting attendance, completion of checklists and participation in functional testing.

1.3 RELATED SECTIONS

A. General Conditions

B. Supplementary Conditions

C. Division One

1.4 COOPERATION WITH TRADES

A. Cooperation with trades of adjacent, related, or affected materials or operations shall be considered a part of this work in order to affect timely and accurate placing of work and bring together in proper and correct sequence, the work of such trades.

1.5 REFERENCES

A. National Electrical Code (NEC)

B. American Society for Testing and Materials (ASTM)

C. Underwriter's Laboratories, Inc. (UL)

D. Insulated Cable Engineer's Association (ICEA).

E. National Electrical Manufacturer's Association (NEMA).

F. Institute of Electrical and Electronic's Engineers (IEEE).

G. American National Standards Institute (ANSI).

H. National Fire Protection Association (NFPA).

I. International Energy Conservation Code (IECC).

1.6 COMPLETE FUNCTIONING OF WORK

A. All work fairly implied as essential to the complete functioning of the electrical systems shown on the Drawings and Specifications shall be completed as part of the work of this Division unless specifically stated otherwise. It is the intention of the Drawings and Specifications to establish the types of the systems, but not set forth each item essential to the functioning of the system. In case of doubt as to the work intended, or in the event of amplification or clarification thereof, the Contractor shall call upon the Architect for supplementary instructions, Drawings, etc.

B. Contractor shall review all pertinent Drawings and adjust his work to all conditions shown there on. Discrepancies between Plans, Specifications, and actual field conditions shall be brought to the prompt attention of the Architect.

1. Approximate location of transformers, feeders, branch circuits, outlets, lighting and power panels, outlets for special systems, etc., are indicated on the Drawings. However, the Drawings, do not give complete and accurate detailed locations of such outlets, conduit runs, etc., and exact locations must be determined by actual field measurement. Such locations will, at all times, be subject to the approval of the Architect.

2. Communicate with the Architect and secure his approval of any outlet (light fixture, receptacle, switch, etc.) location about which there may be the least question. Outlets obviously placed in a location not suitable to the finished room or without specific approval, shall be removed and relocated when so directed by the Architect. Location of light fixtures shall be coordinated with reflected ceiling plans.

C. Additional coordination with mechanical contractor may be required to allow adequate clearances of mechanical equipment, fixtures and associated appurtenances. Contractor to notify Architect and Engineer of unresolved clearances, conflicts or equipment locations.

1.7 SCHEMATIC NATURE OF CONTRACT DOCUMENTS

A. The contract documents are schematic in nature in that they are only to establish scope and a minimum level of quality. They are not to be used as actual working construction drawings. The actual working construction drawings shall be the approved shop drawings.

1.8 CONTRACTOR'S QUALIFICATIONS

A. An approved contractor for the work under this division shall be:

1. A specialist in this field and have the personnel, experience, training, and skill, and the organization to provide a practical working system.

2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their Owners satisfactorily for not less than 3 years.

3. Perform work by persons qualified to produce workmanship of specified quality. Persons performing electrical work shall be required to be licensed. Onsite supervision, journeyman shall have minimum of journeyman license. Helpers, apprentices shall have minimum of apprentice license.

1.9 DATE OF FINAL ACCEPTANCE

A. The date of final acceptance shall be the date of owner occupancy, or the date all punch list items have been completed or final payment has been received. Refer to Division One for additional requirements.

B. The date of final acceptance shall be documented in writing and signed by the architect, owner and contractor.

1.10 DEFINITIONS AND SYMBOLS

A. General Explanation: A substantial amount of construction and Specification language constitutes definitions for terms found in other Contract Documents, including Drawings which must be recognized as diagrammatic and schematic in nature and not completely descriptive of requirements indicated thereon. Certain terms used in Contract Documents are defined generally in this article, unless defined otherwise in Division 1.

B. Definitions and explanations of this Section are not necessarily either complete or exclusive, but are general for work to the extent not stated more explicitly in another provision of the Contract Documents.

C. Indicated: The term "Indicated" is a cross-reference to details, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications and to similar means of recording requirements in Contract Documents. Where such terms as "Shown", "Noted", "Scheduled", "Specified" and "Detailed" are used in lieu of "Indicated", it is for the purpose of helping the reader locate cross-reference material, and no limitation of location is intended except as specifically shown.

D. Directed: Where not otherwise explained, terms such as "Directed", "Requested", "Accepted", and "Permitted" mean by the Architect or Engineer. However, no such implied meaning will be interpreted to extend the Architect's or Engineer's responsibility into the Contractor's area of construction supervision.

E. Reviewed: Where used in conjunction with the Engineer's response to submittals, requests for information, applications, inquiries, reports and claims by the Contractor the meaning of the term "Reviewed" will be held to limitations of Architect's and Engineer's responsibilities and duties as specified in the General and Supplemental Conditions. In no case will "Reviewed" by Engineer be interpreted as a release of the Contractor from responsibility to fulfill the terms and requirements of the Contract Documents.

F. Furnish: Except as otherwise defined in greater detail, the term "Furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

G. Install: Except as otherwise defined in greater detail, the term "Install" is used to describe operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance.

H. Provide: Except as otherwise defined in greater detail, the term "Provide" is used to mean "Furnish and Install", complete and ready for intended use, as applicable in each instance.

I. Installer: Entity (person or firm) engaged by the Contractor or its subcontractor or Sub-contractor for performance of a particular unit of work at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance. It is a general requirement that such entities (Installers) be expert in the operations they are engaged to perform.

J. Imperative Language: Used generally in Specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by the Contractor. For clarity of reading at certain locations, contrasting subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or when so noted by other identified installers or entities.

K. Minimum Quality/Quantity: In every instance, the quality level or quantity shown or specified is intended as minimum quality level or quantity of work to be performed or provided. Except as otherwise specifically indicated, the actual work may either comply exactly with that minimum (within specified tolerances), or may exceed that minimum within reasonable tolerance limits. In complying with requirements, indicated or scheduled numeric values are either minimums or maximums as noted or as appropriate for the context of the requirements. Refer instances of uncertainty to Owner or Engineer via a request for information (RFI) for decision before proceeding.

L. Abbreviations and Symbols: The language of Specifications and other Contract Documents including Drawings is of an abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual word abbreviations of a self-explanatory nature have been included in text of Specifications and Drawings. Specific abbreviations and symbols have been established, principally for lengthy technical terminology and primarily in conjunction with coordination of Specification requirements with notations on Drawings and in Schedules. These are frequently defined in Section at first instance of use or on a Legend and Symbol Drawing. Trade and industry association names and titles of generally recognized industry standards are frequently abbreviated. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of Contract Documents so indicate. Except as otherwise indicated, graphic symbols and abbreviations used on Drawings and in Specifications are those recognized in construction industry for indicated purposes. Where not otherwise noted symbols and abbreviations are defined by the latest ASHRAE Fundamentals Handbook, Chapter 39 "Abbreviations and Symbols", ASME and ASPE published standards.

1.11 DRAWINGS AND SPECIFICATIONS

A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the Work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.

B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In the event of discrepancy between Drawings and Specifications, or within either Drawings or Specifications, the greater or more costly of the discrepancy shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least seven (7) working days prior to bid opening date for issuance of an addendum.

C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is the equivalent of the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturer’s standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.

D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.

E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equivalent capacity, construction, and performance. However, under no circumstances shall any substitution be made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 calendar days prior to the bid date without fail.

F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.

G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equivalent construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.

H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUIVALENT" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUIVALENT" product, material or method may be used if it complies with the Specifications and is submitted for review to the Engineer as outline herein.

I. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) Design Documents and all other trades, including Division 26.

J. Changes in architectural, structural, electrical, mechanical, and plumbing requirements for the substitution shall be the responsibility of the bidder wishing to make the substitution. This shall include the cost of redesign by the affected designer(s). Any additional cost incurred by affected Subcontractors shall be the responsibility of this bidder and not the Owner.

K. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.

L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with the requirements listed above; and if accepted, will issue a letter allowing the substitutions.

M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with their respective trade(s) and all other trades; and to pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Deliver products to the project at such time as the project is ready to receive the equipment, pipe or duct properly protected from incidental damage and weather damage.

C. Damaged equipment shall be promptly removed from the site and new, undamaged equipment shall be installed in its place promptly with no additional charge to the Owner.

1.13 SUBMITTALS

A. Coordinate with Division 01 for submittal timetable requirements, unless noted otherwise within thirty (30) days after the Contract is awarded. The Contractor shall submit an electronic copy of a complete set of shop drawings and complete data covering each item of equipment or material. The submittal of each item requiring a submittal must be received by the Architect or Engineer within the above thirty day period. The Architect or Engineer shall not be responsible for any delays or costs incurred due to excessive shop drawing review time for submittals received after the thirty (30) day time limit. The Architect and Engineer will retain a copy of all shop drawings for their files. All literature pertaining to items subject to Shop Drawing submittal shall be submitted at one time. Submittals shall be placed in one electronic file in PDF format and bookmarked for individual specification sections. Individual electronic files of submittals for individual specifications shall not be permitted. Each submittal shall include the following items:

1. A cover sheet with the names and addresses of the Project, Architect, MEP Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the section number covering the item or items submitted and the item nomenclature or description.

2. An index page with a listing of all data included in the Submittal.

3. A list of variations page with a listing all variations, including unfurnished or additional required accessories, items or other features, between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "NO VARIATIONS". Where variations affect the work of other Contractors, then the Contractor shall certify on this page that these variations have been fully coordinated with the affected Contractors and that all expenses associated with the variations will be paid by the submitting Contractor. This page will be signed by the submitting Contractor.

4. Equipment information including manufacturer's name and designation, size, performance and capacity data as applicable. All applicable Listings, Labels, Approvals and Standards shall be clearly indicated.

5. Dimensional data and scaled drawings as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances clearly indicated and labeled at a minimum scale of 1/4" = 1'-0", as required to demonstrate that the alternate or substituted product will fit in the space available.

6. Identification of each item of material or equipment matching that indicated on the Drawings.

7. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements or accessories shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method.

8. Additional information as required in other Sections of this Division.

9. Certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Drawings and Specifications, signed and dated in long hand. Submittals that do not comply with the above requirements shall be returned to the Contractor and shall be marked "REVISE AND RESUBMIT".

B. Refer to Division 1 for additional information on shop drawings and submittals.

C. Equipment and materials submittals and shop drawings will be reviewed for compliance with design concept only. It will be assumed that the submitting Contractor has verified that all items submitted can be installed in the space allotted. Review of shop drawings and submittals shall not be considered as a verification or guarantee of measurements or building conditions.

D. Where shop drawings and submittals are marked "REVIEWED", the review of the submittal does not indicate that submittals have been checked in detail nor does it in any way relieve the Contractor from his responsibility to furnish material and perform work as required by the Contract Documents.

E. Shop drawings shall be reviewed and returned to the Contractor with one of the following categories indicated:

1. REVIEWED: Contractor need take no further submittal action, shall include this submittal in the O&M manual and may order the equipment submitted on.

2. REVIEWED AS NOTED: Contractor shall submit a letter verifying that required exceptions to the submittal have been received and complied with including additional accessories or coordination action as noted, and shall include this submittal and compliance letter in the O&M manual. The contractor may order the equipment submitted on at the time of the returned submittal providing the Contractor complies with the exceptions noted.

3. NOT APPROVED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is not approved, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or drawings. Contractor shall not order equipment that is not approved. Repetitive requests for substitutions will not be considered.

4. REVISE AND RESUBMIT: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked revise and resubmit, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or provide as noted on previous shop drawings. Contractor shall not order equipment marked revise and resubmit. Repetitive requests for substitutions will not be considered.

5. CONTRACTOR'S CERTIFICATION REQUIRED: Contractor shall resubmit submittal on material, equipment or method of installation. The Contractor's stamp is required stating the submittal meets all conditions of the contract documents. The stamp shall be signed by the General Contractor. The submittal will not be reviewed if the stamp is not placed and signed on all shop drawings.

6. MANUFACTURER NOT AS SPECIFIED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked manufacturer not as specified, the Contractor will automatically be required to furnish the product, material or method named in the specifications. Contractor shall not order equipment where submittal is marked manufacturer not as specified. Repetitive requests for substitutions will not be considered.

F. Materials and equipment which are purchased or installed without shop drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Owner or Engineer for any reason shall be at the expense of the Contractor. The responsible Contractor shall remove the material and equipment noted above and replace with specified equipment or material at his own expense when directed in writing by the Architect or Engineer.

G. Shop Drawing Submittals shall be complete and checked prior to submission to the Engineer for review.

H. Provide detailed shop drawings, descriptive literature, table of contents listing all items being submitted at the beginning of each submittal package, physical data and a specification critique for each section indicating "compliance" and/or "variations" for the following items:

1. Switchboards
2. Distribution Panelboards
3. Panelboards
4. Wiring Gutters
5. Heavy Duty Disconnect Switches
6. Wiring Devices and Plates
7. Conduit and Fittings
8. Wire
9. General Purpose Dry Type Transformers
10. Harmonic Mitigating Type Transformers
11. Fire Alarm System
12. Surge Protection Devices (SPD)

I. Refer to each specification section for additional requirements.

1.14 OPERATION AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 and in addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

1.15 COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of pipe, duct, equipment, and other materials. Include the following:

a. Wall and type locations.

b. Clearances for installing and maintaining insulation.

c. Locations of light fixtures and sprinkler heads.

d. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.

e. Equipment connections and support details.

f. Exterior wall and foundation penetrations.

g. Routing of storm and sanitary sewer piping.

h. Fire-rated wall and floor penetrations.

i. Sizes and location of required concrete pads and bases.

j. Valve stem movement.

k. Structural floor, wall and roof opening sizes and details.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

4. Prepare reflected ceiling plans to coordinate and integrate installations, air distribution devices, light fixtures, communication systems components, and other ceiling-mounted items.

B. This Contractor shall be responsible for coordination of all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.

C. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

1.16 RECORD DRAWINGS

A. Prepare Record Documents in accordance with the requirements of Division 00 and Division 01, in addition to the requirements specified in Division 26.

B. The Contractor shall maintain a separate set of clearly and legibly marked Record Drawings on the job site to record all changes and modifications, including, but not limited to the following: work details, alterations to meet site conditions, and changes made by "Change Order" notices. Mark the drawings with colored pencil(s). These shall be available for review by the Owner, Architect or Engineer during the entire construction stage.

C. The Record Drawings shall be updated concurrently as construction progresses, and in no case less frequently than a daily basis. They shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents. All dimensions shall include at least two dimensions to permanent structure points.

D. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified herein to record the locations and invert elevations of underground installations.

E. If the Contractor does not keep an accurate set of Record Drawings, the pay request may be altered or delayed at the request of the Architect. Delivery of Record Documents is a condition of final acceptance. Record Drawings shall be furnished in addition to Shop Drawings.

F. The Contractor shall submit an electronic copy of the record documents in PDF format and one (1) full size set of Record Drawing prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The drawings shall have the name(s) and seal(s) of the Engineer(s) removed or blanked out and shall be clearly marked and signed on each sheet as follows:

CERTIFIED RECORD DRAWINGS

DATE:

(NAME OF GENERAL CONTRACTOR)

BY: _____

(SIGNATURE)

(NAME OF SUBCONTRACTOR)

BY: _____

(SIGNATURE)

1.17 CERTIFICATIONS AND TEST REPORTS

A. Submit a detailed schedule for completion and testing of each system indicating scheduled dates for completion of system installation and outlining tests to be performed and schedule date for each test. This detailed completion and test schedule shall be submittal at least 90 days before the projected Project completion date.

B. Test result reporting forms shall be submitted for review no later than the date of the detailed schedule submitted.

C. Submit 4 copies of all certifications and test reports to the Architect or Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

D. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section of Division 26.

1.18 MAINTENANCE MANUALS

A. Coordinate with Division 1 for maintenance manual requirements, unless noted otherwise bind together in “D ring type” binders by National model no. 79-883 or equal, binders shall be large enough to allow 1/4” of spare capacity. Three (3) sets of all approved shop drawing submittals, fabrication drawings, bulletins, maintenance instructions, operating instructions and parts exploded views and lists for each and every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and ed for easy reference and shall utilize the individual specification section numbers shown in the Electrical Specifications as an organization guideline. Bulletins containing information about equipment that is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 26 shall be clearly and legibly set forth in memoranda that shall, likewise, be bound with bulletins.

B. Prepare maintenance manuals in accordance with Special Project Conditions, in addition to the requirements specified in Division 26, include the following information for equipment items:

1. Identifying names, name tags designations and locations for all equipment.

2. Fault Current calculations and Coordination Study.

3. Reviewed shop drawing submittals with exceptions noted compliance letter.

4. Fabrication drawings.

5. Equipment and device bulletins and data sheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable, i.e., description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and model numbers of replacement parts.

6. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

7. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions, servicing instructions and lubrication charts and schedules.

8. Equipment name plate data.

9. Wiring diagrams.

10. Exploded parts views and parts lists for all equipment and devices.

11. Color coding charts for all painted equipment and conduit.

12. Location and listing of all spare parts and special keys and tools furnished to the Owner.

13. Furnish recommended lubrication schedule for all required lubrication points with listing of type and approximate amount of lubricant required.

C. Refer to Division 1 for additional information on Operating and Maintenance Manuals.

D. Operating and Maintenance Manuals shall be turned over to the Owner or Engineer a minimum of 14 working days prior to the beginning of the operator training period.

1.19 OPERATOR TRAINING

A. The Contractor shall furnish the services of factory trained specialists to instruct the Owner's operating personnel. The Owner's operator training shall include 12 hours of onsite training in three 4 hour shifts.

B. Before proceeding with the instruction of Owner Personnel, prepare a typed outline in triplicate, listing the subjects that will be covered in this instruction, and submit the outline for review by the Owner. At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the reviewed outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.

C. Refer to other Division 26 Sections for additional Operator Training requirements.

1.20 SITE VISITATION

A. Visit the site of the proposed construction in order to fully understand the facilities, difficulties and restriction attending the execution of the work.

B. Before submitting a bid, it will be necessary for each Contractor whose work is involved to visit the site and ascertain for himself the conditions to be met therein in installing his work and make due provision for same in his bid. It will be assumed that this Contractor in submitting his bid has visited the premises and that his bid covers all work necessary to properly install the equipment shown. Failure on the part of the Contractor to comply with this requirement shall not be considered justification for the omission or faulty installation of any work covered by these Specifications and Drawings.

C. Understand the existing utilities from which services will be supplied; verify locations of utility services, and determine requirements for connections.

D. Determine in advance that equipment and materials proposed for installation fit into the confines indicated.

1.21 WARRANTY

A. The undertaking of the work described in this Division shall be considered equivalent to the issuance, as part of this work, of a specific guarantee extending one year beyond the date of completion of work and acceptance by Owner, against defects in materials and workmanship. Materials, appliances and labor necessary to effect repairs and replacement so as to maintain said work in good functioning order shall be provided as required. Replacements necessitated by normal wear in use or by Owner's abuse are not included under this guarantee.

B. All normal and extended warranties shall include parts, labor, miscellaneous materials, travel time, incidental expenses, freight/shipping, refrigerant, oils, lubricants, belts, filters and any expenses related to service call required to diagnose warranty problems.

1.22 TRANSFER OF ELECTRONIC FILES

A. Project documents are not intended or represented to be suitable for reuse by Architect/Owner or others on extensions of this project or on any other project. Any such reuse or modification without written verification or adaptation by Engineer, as appropriate for the specific purpose intended, will be at Architect/Owner’s risk and without liability or legal exposure to Engineer or its consultants from all claims, damages, losses and expense, including attorney’s fees arising out of or resulting thereof.

B. Because data stored in electric media format can deteriorate or be modified inadvertently, or otherwise without authorization of the data's creator, the party receiving the electronic files agrees that it will perform acceptance tests or procedures within sixty (60) days of receipt, after which time the receiving party shall be deemed to have accepted the data thus transferred to be acceptable. Any errors detected within the sixty (60) day acceptance period will be corrected by the party delivering the electronic files. Engineer is not responsible for maintaining documents stored in electronic media format after acceptance by the Architect/Owner.

C. When transferring documents in electronic media format, Engineer makes no representations as to the long-term compatibility, usability or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by Engineer at the beginning of the Project.

D. Any reuse or modifications will be Contractor's sole risk and without liability or legal exposure to Architect, Engineer or any consultant.

E. The Texas Board of Architectural Examiners (TBAE) has stated that it is in violation of Texas law for persons other than the Architect of record to revise the Architectural drawings without the Architect's written consent.

1. It is agreed that "MEP" hard copy or computer-generated documents will not be issued to any other party except directly to the Architect/Owner. The contract documents are contractually copyrighted and cannot be used for any other project or purpose except as specifically indicated in AIA B-141 Standard Form of Agreement Between Architect and Owner.

2. If the client, Architect or Owner of the project requires electronic media for "record purposes", then AutoCAD/ Revit documents will be prepared by Engineer on electronic media such as removable memory devices, flash drives or CD's. These documents can also be submitted via file transfer protocols. AutoCAD/ Revit files will be submitted with all title block references intact to permit the end user to only view and plot the drawings. Revisions will not be permitted in this configuration.

3. At the Architect/Owner's request, Engineer will assist the Contractor in the preparation of the submittals and prepare one copy of AutoCAD/ Revit files on electronic media or submit through file transfer protocols. The electronic media will be prepared with all indicia of documents ownership removed. The electronic media will be prepared in a ".rvt" or ".dwg" format to permit the end user to revise the drawings.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. The names and manufacturers and model numbers have been used in the Contract documents to establish types of equipment and standards of quality. Where more than one manufacturer is named for a specific item of equipment, only one of the specified manufacturers will be considered for approval. Where only one manufacturer is mentioned with the phrase "or approved equal", Contractor may submit an alternate manufacturer for consideration, provided the following conditions are met:

1. Submit alternate equipment with complete descriptive data in shop drawing form. Provide sample of equipment upon request for review by Architect. Samples will be returned if requested in writing.

2. Alternate equipment must be equal from the standpoint of materials, construction and performance.

3. Alternate submittal must be presented to the Engineer/Architect ten (10) days prior to bid date for approval.

B. The Architect and Engineer shall be the sole judge of quality and equivalence of equipment, materials and methods.

2.2 PRODUCT LISTING

A. Products used on this project shall be listed by Underwriters' Laboratories.

2.3 ACCESS DOORS

A. Wherever access is required in walls or ceilings to concealed junction boxes, pull boxes, equipment, etc., installed under this Division, furnish a hinged access door and frame with flush latch handle to another Division for installation. Doors shall be as follows:

1. Plaster Surfaces: Milcor Style K.

2. Ceramic Tile Surfaces: Milcor Style M.

3. Drywall Surfaces: Milcor Style DW.

4. Install panels only in locations approved by the Architect.

2.4 EQUIPMENT PADS

A. Provide 4-inch-high concrete pads for indoor floor mounted equipment. Pads shall conform to the shape of the equipment with a minimum of 6 inch beyond the equipment. Top and sides of pads shall be troweled to a smooth finish, equivalent to the floor. External corners shall be bullnosed to a 3/4" radius, unless shown otherwise.

B. Provide 6-inch-high concrete pads for all exterior mounted equipment. Pads shall conform to the shape of the equipment with a minimum of 6 inch beyond the equipment. Provide a 4-foot monolithic extension to the pad in front of the equipment for service when mounted on a non-finished area (i.e. landscape, gravel, clay, etc.) Top and sides of pads shall be troweled to a smooth finish. External corners shall be bullnosed to a 3/4" radius, unless shown otherwise.

C. Provide a minimum 6-inch-high, steel reinforced concrete pad for generators. Pads shall be sized 6” larger that the outside perimeter dimensions. Provide a 4-foot monolithic extension to the pad around the equipment for service when mounted on a non-finished area (i.e. landscape, gravel, clay, etc.). Refer to structural details. Top and sides of pads shall be troweled to a smooth finish. External corners shall be bullnosed to a 3/4" radius, unless shown otherwise. The generator shall be bolted to the concrete pad per the manufacturers details.

D. Provide steel reinforced concrete pad for utility transformers. Pads shall comply with Utility Company Standards.

2.5 ESCUTCHEONS

A. Provide heavy chrome or nickel plated plates, of approved pattern, on conduit passing through walls, floors and ceilings in finished areas. Where conduit passes through a sleeve, no point of the conduit shall touch the building construction. Caulk around such conduit with sufficient layers of two hour rated firesafing by Thermafiber 4.0 P.C.F. density, U.S.G. fire test 4/11/78 and seal off openings between conduit and sleeves with non-hardening mastic prior to application of escutcheon plate. Escutcheons shall be Gravler Sure-Lock, or approved equal.

2.6 SPACE LIMITATIONS

A. Equipment shall be chosen which shall properly fit into the physical space provided and shown on the drawings, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearances in accordance with Code requirements. Physical dimensions and arrangement of equipment shall be subject to the approval of the Architect.

2.7 PAINTING

A. All factory assembled equipment for electrical work, except light fixtures, that normally is delivered with a factory applied finish shall be delivered with a hard surface factory applied finish such as baked-on machinery enamel which will not require additional field painting. The finish shall consist of not less than 2 coats of medium gray color paint USA No. 61 Munsell Notation 8-3G, 6. 10/0.54 enamel. This Contractor shall protect this finish from damage due to construction operations until acceptance of the building. He shall be responsible for satisfactorily restoring any such finishes or replacing equipment that becomes stained or damaged.

2.8 ELECTRICAL SYSTEM IDENTIFICATION

A. Conduit Systems: Provide adequate marking of major conduit which is exposed or concealed in accessible spaces to distinguish each run as either a power or signal/communication conduit. Except as otherwise indicated, use orange banding with black lettering. Provide self-adhesive or snap-on type plastic markers. Indicate voltage for that raceway. Locate markers at ends of conduit runs, on pull boxes, on junction boxes, near switches and other control devices, near items of equipment served by the conductors, at points where conduit passes through walls or floors, or enters non-accessible construction and at spacings of not more than 50 feet along each run of conduit. Switch-leg conduit and short branches for power connections do not have to be marked, except where conduit is larger than ¾ inch. Branch circuit conduits, junction boxes and pull boxes shall be marked with a permanent marker indicating panel name and branch circuit numbers.

B. Underground Cable Identification: Bury a continuous, preprinted, bright colored plastic ribbon cable marker with each underground cable (or group of cables), regardless of whether conductors are in conduit, duct bank, or direct buried. Locate each directly over cables, 6 to 8 inches below finished grade.

C. Identification of Equipment:

1. All major equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way. Provide black back plate with white letters and numbers for normal equipment. Provide red back plate with white letters and numbers for optional emergency equipment. Provide yellow back plate with white letters and numbers for Life safety equipment.

2. A black-white-black laminated plastic engraved identifying nameplate shall be secured by stainless steel screws to each automatic transfer switch, switchboard, distribution panel, motor control center, motor starter panels and panelboards.

a. Identifying nameplates shall have ¼ inch high engraved letters and shall contain the following information:

1) Name

2) Voltage

3) Phase

4) "3" or "4" wire, and

5) Where it is fed from.

b. An example of a panelboard nameplate is:

Center Panel – 1HB

480/277 volt, 3 phase, 4 wire

Center Fed from DP2

c. An example of an automatic transfer switch nameplate is:

Center ATS #2

480/277 volt, 3 phase, 4 wire, 4 pole

Center Fed from MSB and DPE

3. Each feeder device in a switchboard, distribution panel, and motor control center device shall have a nameplate showing the load served in ½ inch high engraved letters.

4. A black-white-black laminated plastic engraved identifying nameplate shall be secured by screws to each transformer, safety switch, disconnect switch, individual motor starter, enclosed circuit breaker, wireway, and terminal cabinet.

   a. Identifying nameplates shall have 1/4 inch high engraved letters and shall indicate the equipment served.

   b. An example of a disconnect switch is: AHU-1.

5. Prohibited Markings: Markings which are intended to identify the manufacturer, vendor, or other source from which the material has been obtained are prohibited for installation within public, tenant, or common areas within the project. Also, prohibited are materials or devices which bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters' Laboratories, Inc.), and approval labels are exceptions to this requirement.

6. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.

7. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical system, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING."

D. Identification of Wiring Devices

1. Contractor shall indicate the circuit serving each wiring device. Provide a typewritten label located on the inside face of the coverplate for all recessed mounted devices and on the outside face of the coverplate on all surface mounted devices.

PART 3 - EXECUTION

3.1 EXCAVATING AND BACKFILLING

A. Trenching and backfilling and other earthwork operations required to install the facilities specified herein shall conform to the applicable requirements of Division 2 (95% of maximum standard density). Where trenching or excavation is required in improved areas, the backfill shall be compacted to a condition equal to that of adjacent undisturbed earth and the surface of the area restored to the condition existing prior to trenching or excavating operations. Provide a minimum of 3” of sand underneath all conduits. The plans indicate information pertaining to surface and sub-surface obstructions; however, this information is not guaranteed. Should obstructions be encountered whether or not shown, the Contractor shall alter routing of new work, reroute existing lines, remove obstructions where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of new work and leave existing surfaces and structures in a satisfactory and serviceable condition. All work shall comply with OSHA Standards.

3.2 WORKMANSHIP AND CONCEALMENT

A. The work of this Section shall be performed by workman skilled in their trade. Installation shall be consistent in completeness whether concealed or exposed. Each item of electrical work shall be concealed in walls, chases, under floors and above ceilings except:

1. Where shown to be exposed.

2. Where exposure is necessary to the proper function.

3.3 SLEEVES, CUTTING AND PATCHING

A. This section shall be responsible for placing sleeves for all conduit passing through walls, partitions, sound walls, beams, floors, roof, etc. Sleeves through below-grade walls shall use water-tight fitting manufactured by O-Z/Gedney.

B. Contractor shall install underground raceways including but not limited to feeders, service laterals, branch circuit and telecommunications. Contractor shall saw cut existing hard surfaces, when required for installation. Contractor shall patch surface to match existing conditions. Contractor shall replace all landscaping material when raceways are installed in these areas. Submit proposed method for patching for review.

C. All cutting and patching will be done under another Division, but this Section will be responsible for timely performance of this work and layout of holes and setting sleeves.

D. All un-used sleeves shall be sealed with 2 hour UL approved fire sealant manufactured by “3M” or approved equal.

E. Refer to 26 05 33 for additional requirements.

3.4 ELECTRICAL GEAR

A. Install all electrical equipment in accordance with the National Electrical Code and as shown on the drawings.

B. Lighting contactors, time clocks, fire alarm equipment, security equipment disconnect switches, etc. mounted in mechanical/electrical rooms shall be mounted at a working height not requiring a ladder, when wall space is available. Installation of these devices at greater elevations shall be approved by the Engineer. Contractor shall provide a coordination sketch of each mechanical/electrical room noting locations and mounting heights of all electrical devices (note bottom and top elevations) shown to be installed. Sketches shall be provided to the Engineer for review and the general contractor for coordination with other trades working in these rooms.

C. Fire retardant back boards secured to drywall studs may be used for contactors, time clocks, fire alarm equipment, security equipment, and disconnect switches 60 amp or smaller. All other wall mounted devices shall be mounted to unistrut. Unistrut shall be securely mounted to the floor and structural ceiling. Toggle bolts or anchor bolts attached to drywall is not acceptable.

3.5 CLEANING

A. Clean lighting fixtures and equipment.

B. Touch-up and refinish scratches and marred surfaces on panels, switches, starters, and transformers.

3.6 CORROSIVE AREAS

A. In areas of a corrosive nature, which include but are not limited to the following: pool equipment rooms, cooling towers and areas subject to salt air, etc., provide NEMA 4 X stainless steel or fiberglass reinforced enclosures for contactors, panel boards, controllers, starters, disconnects and materials used as supporting means (i.e. plastibond unistrut, pipe, fittings). The use of spray on coating may be acceptable in some applications.

3.7 TESTS AND INSPECTIONS

A. Tests and inspection requirements shall be coordinated with Division I.

B. Date for final acceptance test shall be sufficiently in advance of completion date of contract to permit alterations or adjustments necessary to achieve proper functioning of equipment prior to contract completion date.

C. Conduct re-tests as directed by Architect on portions of work or equipment altered or adjusted as determined to be necessary by final acceptance test. No resultant delay or consumption of time as a result of such necessary re-test beyond contract completion date shall relieve Contractor of his responsibility under contract.

D. Put circuits and equipment into service under normal conditions, collectively and separately, as may be required to determine satisfactory operation. Demonstrate equipment to operate in accordance with requirements of these specifications. Perform tests in the presence of Architect. Furnish instruments and personnel required for tests.

E. Final Inspection:

1. At the time designated by the Architect, the entire system shall be inspected by the Architect and Engineer. The contractor or his representative shall be present at this inspection.

2. Panelboards, switches, fixtures, etc., shall be cleaned and in operating condition.

3. Certificates and documents required hereinbefore shall be in order and presented to the Architect prior to inspection.

4. Panel covers, junction box covers, etc., shall be removed for visual inspection of the wire, bus bars, etc.

5. After the inspection, any items which are noted as needing to be changed or corrected in order to comply with these specifications and the drawings shall be accomplished without delay.

F. The contractor shall provide a thermographic test using an independent testing laboratory using an infrared scanning device. This test shall include but not limited to all switchboards, distribution panelboards, panelboards, automatic transfer switches and other electrical distribution devices. This test shall be conducted to locate high temperature levels. This test shall be conducted between 3 to 8 months after occupancy, but not beyond the one year warranty period. Submit test to the architect and engineer using test reporting forms. All unacceptable conditions shall be corrected prior to the end of the warranty period.

END OF SECTION

SECTION 26 02 01 - COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions 01 31 00 and Supplementary Conditions apply to all Work herein.

1.2 COORDINATION DRAWINGS

A. The Contractor shall take the lead in coordinating the Mechanical, Electrical, Plumbing, Communications, Electronic Safety/Security and Fire Protection systems within the building.

B. The Contractor shall coordinate a three-dimensional (3D) model of the building which includes the Mechanical, Electrical, Plumbing, and Fire Protection systems. The Mechanical, Electrical, Plumbing, and Fire Protection Contractors shall prepare their work and generate 3D models which will be given to the Contractor for coordination. The Contractor will be provided with the REVIT model that was used to generate the contract documents, this file may be used as the background file. The Contractor shall replace the systems drawn with the actual shop drawing models. The Contractor is not limited to using REVIT, but may use any 3-D software in generating and combining the coordination model.

C. Submitting the contract drawings as coordination drawings will not be acceptable.

D. The model shall include detailed and accurate representations of all equipment to be installed based upon the reviewed equipment submittals.

E. The Contractor shall hold a 3-D coordination meeting with all sub-contractors present to review the model and discuss coordination of the installation of the building systems.

F. Upon completion of the coordination meeting, the Contractor shall submit the 3-D model and 1/4" scale drawings for review.

G. The model shall detail major elements, components, and systems in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of pipe, duct, equipment, and other materials. Include the following:

a. Wall and type locations.

b. Clearances for installing and maintaining insulation.

c. Locations of light fixtures and sprinkler heads.

d. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.

e. Equipment connections and support details.

f. Exterior wall and foundation penetrations.

g. Routing of storm and sanitary sewer piping.

h. Fire-rated wall and floor penetrations.

i. Sizes and location of required concrete pads and bases.

j. Valve stem movement.

k. Structural floor, wall and roof opening sizes and details.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

4. Prepare reflected ceiling plans to coordinate and integrate installations, air distribution devices, light fixtures, communication systems components, and other ceiling-mounted items.

H. Sequence of Coordination

1. Below is hierarchy of model elements and the sequencing by which the models will be coordinated:

a. Structural and Architectural model

b. Miscellaneous steel

c. Perform preliminary space allocation

d. Identify hard constraints (locations of access panels, lights, A/V space requirements, etc.)

e. Main and medium pressure ducts from the shaft out

f. Main graded plumbing lines and vents

g. Sprinkler mains and branches

h. Cold and hot water mains and branches

i. Lighting fixtures and plumbing fixtures

j. Smaller sized ducts and flex ducts

k. Smaller size cold water and hot water piping, flex ducts, etc.

I. The Contractor shall not install any item until the coordination has been completed and reviewed by the Construction Manager, Owner, and A/E team.

J. This Contractor shall be responsible for coordination of all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.

K. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

END OF SECTION

SECTION 26 03 13 - ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

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

B. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The contractor shall allow the Owner 2 weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

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

1.2 RELATED SECTIONS

A. Section 01120 - Alteration Project Procedures.

B. Section 02072 - Minor Demolition for Remodeling.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

B. Include in the contract price all rerouting of existing conduits, wiring, outlet boxes, fixtures, etc., and the reconnecting of existing fixtures as necessitated by field conditions to allow the installation of the new systems. Furnish all temporary conduit, wiring, boxes, etc., as required to maintain lighting and power service for the existing areas with a minimum of interruption. Remove wire and conduit back to nearest accessible active junction box and extend to existing homeruns as required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Owner before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with Utility Company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner and local fire service at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Section 01120, Section 02072, and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets, which are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

L. Where existing construction is removed to provide working and extension access to existing utilities, contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

M. Where partitions, walls, floors, or ceilings of existing construction are being removed, all contractors shall remove and reinstall in locations approved by the Architect all devices required for the operation of the various systems installed in the existing construction.

N. During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, etc., shall be arranged so as to present minimum hazard or interruption to the occupants of the building.

O. Certain work during the demolition phase of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner`s Representative at least 72 hours in advance.

P. All existing lighting fixtures, switches, outlets, speakers, materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.

Q. Electrical equipment, outlets, speakers, circuits to mechanical and building systems equipment, etc., which are to remain but which are served by conduit and/or circuiting that is disturbed by the remodeling work, shall be reconnected in such as manner as to leave it in proper operating condition.

R. Existing branch circuit wiring which is to be removed, shall be pulled from the raceways and the empty conduit shall be removed to a point of permanent concealment.

S. Within the remodeled or alteration areas where existing walls are being removed, all existing lighting fixtures, switches, receptacles, other materials and equipment and their appurtenances shall be removed, where required by the remodel work either shown or specified.

T. New circuiting indicated to be connected to existing panels shall be connected to "spares" and/or "released" breakers as applicable, or new breakers provided where space is available. Contractor shall verify the existing panel load and feeder capacity prior to adding any additional loads.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Section 01120.

3.6 REMOVAL OF MATERIALS

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

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

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

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

END OF SECTION

SECTION 26 05 19 - WIRE, CABLE AND RELATED MATERIALS

PART 1 - GENERAL

1.1 SCOPE

A. Provide 600 volt building wire, cable and connectors and 300 volt wire, cable and connectors.

B. WORK INCLUDED: Include the following Work in addition to items normally part of this Section.

1. Automatic Control Wiring.

2. Connection of equipment shown.

3. Fire Alarm System.

4. Voice Communications and Sound System.

C. WORK SPECIFIED ELSEWHERE:

1. Heating, ventilating, and air conditioning equipment.

2. Structured cabling system.

1.2 REFERENCE STANDARDS

A. UL 4 - Armored Cable

B. UL 83 - Thermoplastic-Insulated Wires and Cables

C. UL 1063 - Standard for Machine-Tool Wires and Cables

D. UL 1569 - Metal-Clad Cables

E. UL 1685 - Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

F. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire

G. NFPA 70 - National Electrical Code

H. All wire cable and connectors shall be UL approved.

I. NEMA

J. NEMA Bulletin 119

1.3 ACCEPTABLE MANUFACTURERS

A. 600 VOLT WIRE AND CABLE

1. Southwire

2. Encore

3. Cerro

4. Atkore

B. 300 VOLT WIRE AND CABLE

1. Westpenn

2. Beldon

3. Alpha

4. Tappan - Southwire

C. FLEXIBLE CABLE SYSTEMS

1. AFC Modular Cable Systems

2. Kaf-Tech

D. CONNECTORS

1. Ilsco

2. Cooper

3. AMP - TYCO

4. Burndy

5. Ideal

6. 3M

7. O.Z. Gedney

8. Thomas & Betts

9. Buchanan

1.4 SUBMITTALS

A. Shop drawings shall include, but not limited to:

1. Cutsheets of wire, cable and connectors to indicate the performance, fabrication procedures, product variations, and accessories.

1.5 REQUIREMENTS OF REGULATORY AGENCIES WORK IN ACCORDANCE WITH:

A. National Electrical Code.

B. Local, municipal, or state codes that have jurisdiction.

PART 2 - PRODUCTS

2.1 WIRING

A. All wire shall be new and continuous without weld, splice, or joints throughout its length. It must be uniform in cross-section, free from flaws, scales and other imperfections.

B. WIRE MATERIAL: Conductors shall be soft drawn, annealed copper. Aluminum wiring is not acceptable unless otherwise noted on drawings.

C. TYPES:

1. Provide type “THHN/THWN-2” insulation for all buried feeders and service entrance conductors.

2. Provide type “THHN/THWN-2” insulation for all branch circuits and above grade feeders.

3. All wire No. 8 and larger shall be stranded. All wire No. 10 and smaller shall be stranded or solid.

4. Provide type "XHHW" or other 90 degrees insulation wiring for branch circuit wiring installed through continuous rows of fixture bodies.

5. All 300-volt cable including but not limited to telephone, fire alarm, data, CATV and security shall be UL listed for use in return air plenums.

6. All dimming conductors shall be 300 volt, 75 C plenum rated. Dimming conductors shall be solid. Stranded conductors are not acceptable.

D. CONDUCTOR SIZES

1. Feeder conductors shall be sized for a maximum of 2% drop in rated voltage at scheduled load.

2. Branch circuit conductors shall be sized for a maximum 3% drop in the rated voltage to the longest outlet on the circuit.

3. Minimum wire shall be 12 AWG, unless otherwise shown on Drawings or required by Code.

4. Minimum wire size for 0-10v dimming controls shall be 18 AWG for conductors not exceeding 300 feet circuit length (one-way) and 16 AWG for those exceeding 300 feet (one-way).

E. COLOR CODING: No. 6 or larger shall use tape for color coding. No. 8 and smaller wire shall be color coded in accordance with the governing authority requirements or as follows:

120/208 Volt

Neutral: White

Phase A: Black

Phase B: Red

Phase C: Blue

Ground: Green

277/480 Volt

Neutral: Gray

Phase A: Brown

Phase B: Purple

Phase C: Yellow

Ground: Green

120/240 Volt

Neutral: White

Phase A: Black

Phase B: Orange

Phase C: Blue

Ground: Green

0-10 Volt dimming conductors

Purple (source)

Pink (common)

2.2 METAL CLAD CABLE - TYPE MC (600 VOLT)

A. Provide soft drawn solid copper conductors with type THHN/ THWN-2 insulation rated 90° C in dry locations. All conductors shall be color coded. Include a white neutral and green insulated grounding conductor. Branch circuits shall include a double sized neutral when more than one phase conductors are being utilized. The conductors shall use a binding tape with a printed legend and assembled in an interlocking steel armor raceway.

PART 3 - EXECUTION

3.1 WIRE

A. Do not pull wire into conduit until Work of an injurious nature is completed. Where two or more circuits run to a single outlet box, each circuit shall be properly tagged. Wyreze or approved equal may be used as a lubricant where necessary.

B. Splices shall be fully made up in outlet boxes with compression crimp-on type splice connectors.

C. Joints and splices will not be permitted in service entrance or in feeders. Joints in branch circuits will be permitted where branch circuits divide, and then shall consist of one through-circuit to which the branch shall be spliced. Joints shall not be left for the fixture hanger to make. Connect joints and splices with Buchanan Series "2000" solderless connectors complete with insulating caps or properly sized twist on wire nuts. “Wago” push-in connectors are not acceptable.

D. All stranded conductors shall be furnished with lugs or connectors.

E. Connectors furnished with circuit breakers or switches shall be suitable for copper wire termination.

F. “Sta-Cons” shall be used to terminate stranded conductors on all switches and receptacles.

G. Metal Clad Cable - Type MC

1. All light fixtures shall be connected from a branch circuit junction box using 1/2" flexible metal conduit or MC cable fixture pigtails not exceeding 8'-0". Provide #12 AWG conductors. All fixtures must be grounded by using a grounding conductor. Fixture to fixture wiring installed in accessible ceiling is not permitted. Fixture whips shall not lay on ceiling tile or grid. Provide caddy clips to provide additional support.

H. All stranded #10 and small conductors shall be terminated with an approved solderless terminal if the device or light fixture does not have provisions for clamp type securing of the conductor.

I. The jacket for all travelers used on 3-way and 4-way switches shall be pink.

J. Route conductors for 480Y/277 systems in a separate raceway. Do not combine with 208Y/120 volt or 120/240 volt systems.

K. Emergency circuits shall not be routed with normal conductors.

3.2 BALANCING SYSTEM

A. The load on each distribution and lighting panel shall be balanced to within 10% by proper arrangement of branch circuits on the different phase legs. Provide written documentation showing results. Submit with O & M manuals.

3.3 LOW VOLTAGE WIRING

A. Low voltage wiring, including dimming conductors, shall be plenum rated. All wiring in mechanical rooms, electrical rooms, drywall ceiling, inaccessible areas, underground, plaster ceiling, inside concealed walls areas exposed to occupant view, and other areas subject to physical damage shall be run in conduit.

B. Low voltage wiring shall be routed in separate raceways from power wiring systems.

C. Sleeves shall be placed in the forms of concrete, masonry and fire rated walls, floor slabs and beams, for the passage of wiring. Sleeves should be set in place a sufficient time ahead of the concrete work so as not to delay the work. Sleeves shall be rigid galvanized steel.

D. Provide Caddy J-hooks supported independently from other system to support cable at 4-foot on center or closer if required by manufacturer.

E. Provide a junction box to make up all joints and splices.

F. Provide dimming conductors for all lighting circuits located in spaces with dimmer switches and theatrical lighting as indicated on the drawings and as specified.

3.4 GROUNDING

A. Permanently connect all conduit work, motors, starters, and other electrical equipment to grounding system in accordance with NFPA 70.

3.5 CABLE SUPPORTS

A. Provide cable supports in all vertical raceways in accordance with Article 300.19 of NFPA 70.

3.6 DEFECTS

A. Defects shall include, but are not to limited to, the following:

1. Tripping circuit breakers under normal operation.

2. Improperly connected equipment.

3. Damaged, torn, or skinned insulation.

END OF SECTION

SECTION 26 05 33 - RACEWAYS

PART 1 - GENERAL

1.1 SCOPE

A. Provide electrical raceways and fittings as shown, scheduled and specified.

B. The types of raceways and fittings required are as follows:

1. Rigid hot-dipped galvanized steel conduit (GRC) (RMC)
2. Intermediate hot-dipped galvanized steel conduit (IMC)
3. Electrical metallic tubing (EMT)
4. PVC (Sch. 40 & 80)
5. Flexible metal conduit (FMC)
6. Liquid-tight flexible metal conduit (LFMC)
7. PVC coated rigid galvanized steel conduit (GRCC)
8. Rigid Aluminum Conduit (RAC)

1.2 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit - Aluminum (ERMC-A); 2025.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.

F. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

G. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

H. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.

I. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

J. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

K. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

L. NEMA FB-1

M. NEMA TC3

1.3 ACCEPTABLE MANUFACTURERS

A. Raceways

1. Allied
2. Republic
3. Prime Conduit (Carlon)
4. Wheatland Tube
5. Cantex
6. Western Tube
7. Robroy Industries

B. Fittings

1. Appleton
2. Crouse Hinds
3. Steel City
4. O.Z. Gedney
5. Carlon
6. Raco, Inc.
7. Bridgeport

C. Boxes

1. RACO
2. Thomas and Betts
3. EATON
4. Crouse-Hinds
5. Appleton

D. Surface

1. Hubbell

2. Wiremold

1.4 SUBMITTALS

A. Product data shall include but not be limited to:

1. Cutsheets for raceways, fitting, solvents, primers, etc.

1.5 REQUIREMENTS OF REGULATORY AGENCIES WORK IN ACCORDANCE WITH

A. NFPA 70

B. Local, municipal, or state codes that have jurisdiction.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (GRC/RMC)

1. Construction, Materials, Codes, Standards:

a. Article 344 - NFPA 70.

b. Hot-dip galvanized rigid steel conduit, galvanized after fabrication. Products shall comply with UL 6 and ANSI C80.1. All threads shall be galvanized after cutting. A uniform zinc coating shall be applied to the inner and outer walls.

c. Fittings shall be threaded and shipped with thread protectors. Set Screw are not acceptable. Die Cast Fittings are not acceptable.

2. Permitted for use in the following locations:

a. Outdoor or Exterior (Exposed)

b. Indoors, Conditioned Spaces

c. Unconditioned Spaces

d. Underslab (Void Form Slab): where not in contact with earth – only permitted where indicated on plan.

e. Underslab (Suspended Slab): Permitted – only where indicated on plan.

3. Prohibited Locations: Underground, Corrosive environments, Underslab (Slab on Grade), Foundation penetrations.

4. Specific Uses: Exposed Exterior installations, where within or attached to masonry or concrete, where subject to damage.

B. Intermediate Metal Conduit (IMC)

1. Construction, Materials, Codes, Standards:
    a. Article 342 - NFPA 70.
    b. Conduit shall be similar to rigid steel conduit except thinner wall.
    c. Fittings shall be threaded hot-dipped galvanized and shipped with thread protectors. Set Screw or Die Cast Fittings are not acceptable
    d. Products shall comply with UL 1242.
2. Permitted for use in the following locations:
    a. Outdoor or Exterior (Exposed)
    b. Indoors, Conditioned Spaces
    c. Unconditioned Spaces
    d. Underslab (Void Form Slab): not in contact with earth only as indicated on plan.
    e. Underslab (Suspended Slab): only where indicated on plan.
3. Prohibited Locations: Corrosive Environment, Underground, Underslab (Slab on Grade), Foundation Penetrations
4. Specific Uses: Exposed exterior locations, Rooftops exposed to sunlight

C. Electrical Metallic Tubing (EMT)

1. Construction, Materials, Codes, Standards:
    a. Article 358 - NFPA 70.
    b. EMT shall be made of hot-dip galvanized strip steel. The interior shall be coated with a corrosion-resistant lubricant for ease of wiring pulling.
    c. Shall utilize steel insulated throat, set-screw connectors and steel set-screw couplings in all indoor conditioned spaces.
    d. Shall utilize steel insulated throat, threadless, watertight compression type connectors and steel threadless watertight compression type coupling in all non-conditioned spaces and in grout filled CMU walls.
    e. Products shall comply with UL 797 and ANSI C80.3.
2. Permitted for use in the following locations:
    a. Indoors, Conditioned Spaces
    b. Unconditioned Spaces

3. Prohibited Locations: Corrosive Environment, Underground, Underslab (all types), Wet or Damp Locations, Exteriors, Within Concrete, foundation penetrations.

4. Specific Uses: Primary use conduit for indoor spaces, where conditioned. Unconditioned locations shall require use of insulated throat water tight fittings.

D. Rigid Nonmetallic Conduit (PVC Schedule 40 & 80)

1. Construction, Materials, Codes, Standards:

a. Article 352 and 300.6 - NFPA 70.

b. Conduit shall be schedule 40 or 80 polyvinyl chloride (PVC), UV stabilized, rated for 90°C conductors.

c. Fittings shall be solvent weld socket type.

d. Products shall comply with UL 651.

2. Permitted for use in the following locations:

a. Underground (Earth, outside foundation perimeter)

b. Underslab (Slab on Grade): only where indicated on plan.

c. Under Driveways, roadways, or vehicular crossings, and where required by Utility Company: PVC Schedule 80

1) PVC Schedule 40 allowed where concrete encased.

3. Prohibited Locations: return air Plenums, interstitial spaces, Outdoor or Exterior (Exposed), Unconditioned spaces, corrosive environments, underslab (suspended or void form), foundation penetrations.

4. Specific Uses: For use underground or underslab (Slab on grade). Underground use is approved for all locations where transiting a project site, not underneath any foundation. For locations under the footprint of building/foundation, use only authorized where indicated on drawings.

E. Flexible Metal Conduit (FMC/Greenfield)

1. Construction, Materials, Codes, Standards:

a. Article 348 - NFPA 70.

b. Spirally wound continuously interlocked zinc coated strip steel.

c. Fittings shall be one screw for smaller than 1-1/2-inch, two screw for 1-1/2-inch and larger, double clamp steel or malleable iron, either cadmium plated or hot-dip galvanized.

d. Products shall comply with UL 360.

2. Permitted for use in the following locations:

    a. Indoors, Conditioned Spaces.

3. Prohibited Locations: outdoors/Exterior, unconditioned spaces, Corrosive, Wet, Concrete, underslab(all types), underground, foundation penetrations.

4. Specific Uses and Applications: For use in connection to rotating equipment within conditioned spaces, including plenums. Also permitted for use with empty raceways in walls for use with Low Voltage, AV, telecom cabling.

F. Liquid-Tight Flexible Steel Conduit (LFMC/Seal Tite)

1. Construction, Materials, Codes, Standards

    a. Article 350 - NFPA 70.

    b. Spirally wound continuously interlocked zinc coated strip steel with a UV stabilized polyvinyl chloride (PVC) outer jacket bonded to the conduit.

    c. Fittings shall be compression type, malleable iron, with insulated throat, either cadmium plated or hot-dip galvanized. Plastic is not acceptable.

2. Permitted for use in the following locations:

    a. Outdoor or Exterior (Exposed)

    b. Indoors, Conditioned Spaces

    c. Unconditioned Spaces

3. Prohibited Locations: Concrete, corrosive, underground, underslab (all types), foundation penetrations.

4. Specific Uses and Applications: Primary use is connection to rotating equipment at unconditioned spaces. Transformer Primaries and Secondaries (excluding service transformer).

G. PVC Coated Rigid Galvanized Steel Conduit (GRCC/Plastibond)

1. Construction, Materials, Codes, Standards:

    a. Article 344 and 300.6 - NFPA 70.

    b. Conduit shall be same as rigid metal conduit with a factory-applied 40-mil-thick covering of polyvinyl chloride (PVC) bonded to the metal, coated inside and outside.

2. Permitted for use in the following locations:

    a. Outdoor or Exterior (Exposed): except for stub-ups and penetrations.

    b. Corrosive Environment: required throughout

1) Where corrosive environments exist, such as pools, pool pump room, corrosive chemical storage, GRCC shall be provided throughout, up to the point of sealed penetration into a non-corrosive environment.

c. Underground (Earth, outside foundation perimeter): Required at bends of 15° or greater, Penetrations through concrete, Stub-ups through foundation or grade at concrete.

d. Foundation Penetrations

3. Prohibited Locations: extended runs exposed to sunlight, Plenums, Underslab except for penetrations (all foundation types).

4. Specific Uses: For use at Cooling Towers, Natatoriums, Pools, Pool Decks, Pool pump rooms, chemical storage, corrosive environments.

H. Rigid Aluminum Conduit (RAC)

1. Construction, Materials, Codes, Standards:

a. Article 344 - NFPA 70.

b. Rigid aluminum (alloy 6063-T1) conduit shall be manufactured using 6063 Alloy in temper designation T-1.

c. Fittings for rigid aluminum conduit shall be threaded aluminum shipped with thread protectors. Set Screw or Die Cast Fittings are not acceptable

d. Products shall comply with UL 6A and ANSI C80.5.

2. Permitted for use in the following locations:

a. Outdoor or Exterior (Exposed)

b. Indoors, Conditioned Spaces

c. Unconditioned Spaces

3. Prohibited Locations: Corrosive environments, underground, within concrete, underslab (all types), foundation penetrations.

4. Specific Uses and Applications: Exposed Exterior such as rooftops or canopies.

2.2 PULL BOXES

A. Exterior in-ground pull boxes shall be concrete or polymer as manufactured by Brooks, Dalworth, Hubbell Quazite, or approved equivalent. Covers shall include identification of systems contained.

B. Where located in Roadways, Parking Lots, or Traffic zones, Pullboxes shall be rated to accept a minimum 22,500 lb. load per ANSI/SCTE 77.

C. All Pullboxes shall be sized based on NEC wire-bending requirements at each individual location.

D. Covers shall include identification of systems contained, such as:

1. Electrical

2. Telecom

3. Communications

4. Others, as required.

E. Pull boxes in pole bases shall be as manufactured by Carlon.

F. Pullboxes shall be provided in all raceway systems upon exceeding the following conditions:

1. The equivalent of 270° in conduit bends, or after (3) 90° bends.

2. Any 400ft of linear conduit or duct bank continuous segments.

3. Where required to make transitions to prevent the damaging of conductor insulation.

2.3 WIREWAYS

A. Wireways shall be made of not less than 16-gauge sheet steel for 4 inch and 6 inch square sizes and 14 gauge steel for 8 inch and 12 inch square sizes. Couplings end plates, and knockouts shall be furnished as required. Each section of wireways shall be rigidly supported.

B. The finish shall be ANSI-49 gray epoxy paint applied by a cathodic electrode position paint process over a corrosion resistant phosphate preparation for NEMA 1 wireways. Provide galvanized steel for NEMA 3R wireways. NEMA 3R wireways and auxiliary gutters are for horizontal mounting only.

2.4 BUSHINGS

A. Provide nylon bushing on end of all low voltage cabling system conduits (sleeves, rough-ins, etc.).

B. Provide Grounding Bushing as required in 26 05 26 - Grounding.

PART 3 - EXECUTION

3.1 PROVIDE CONDUIT AS FOLLOWS:

A. GENERAL: The Drawings are diagrammatic and are intended to show the general location of outlets, devices, fixtures, and arrangement and control of circuits. The Contractor shall determine exact locations by actual measurement of the building or by reference to the Architectural Drawings.

B. All wiring shall be installed in galvanized rigid steel, rigid aluminum conduit or electrical steel tube (EMT) unless otherwise noted or specified. Each raceway shall be sized to contain the number of conductors required to comply with the latest edition of NFPA 70. Conduit sizes that are scheduled or shown on the drawings shall take preference.

C. Raceways shall not be routed below or within slab-on-grade foundations, or below grade of suspended slab structures, unless specifically noted or indicated otherwise on plan.

D. EMT in sizes up to 4 inches when concealed or not exposed to damage and located indoors only. (EMT is not acceptable in wet and damp location.)

E. MINIMUM SIZE: 3/4 inch.

F. Flexible conduit of any type shall not be used except for connections to rotating or vibrating equipment, or where use for low voltage raceways. All conduit shall be provided as a rigid type conduit for homeruns, runs between termination boxes, outlets, etc.

G. Fixture whips: Refer to 26 51 19 for additional information.

H. Of such size, and so installed that conductors may be drawn in without injury or excessive strain.

I. Where entering panels, pull boxes, junction boxes, or outlet boxes, shall be secured in place with lock nuts inside and outside, and insulated bushings inside.

J. Have Red seal type VCC or approved equal cable supports in risers, as required by NFPA 70.

K. Have ends reamed after cutting and application of die.

L. Keep conduit corked and dry during construction and swab out before conductors are pulled.

M. Have bends and offsets made with approved tools. Bends or offsets in which the pipe is crushed or deformed shall not be installed.

N. Have O.Z. Gedney or approved equal expansion fittings where crossing building expansion joints.

O. Fixtures in finished areas having suspended acoustical ceilings shall be connected to outlet boxes of lighting grid by flexible metal conduit; length not to exceed ten feet (six feet if using 3/8” manufactured fixture “whips”).

P. Outlet boxes in partitions shall never be set back-to-back. They shall be offset to prevent undue noise transmission from room to room.

Q. Each entire conduit system shall be installed complete before any conductors are drawn in. Every run of conduit shall be finished before covering up to guard against obstructions and omissions.

R. Sleeves shall be placed in the forms of concrete, masonry and fire rated walls, floor slabs and beams, for the passage of conduits. Sleeves should be set in place a sufficient time ahead of the concrete work so as not to delay the work. Sleeves shall be rigid galvanized steel with a minimum thickness of 1.07MM and set to extend 4” above slab.

S. All pipe penetrations through walls and concrete floors shall be fire rated by applying USG Thermafiber in the space between the concrete and the pipe. The fire rating shall be additionally sealed by using 3M brand model CP 25 or 303 fire barrier caulk and putty. All fire rating material shall be installed in accordance with manufacturer`s printed instructions.

T. All conduit shall be cleaned and swabbed to remove all foreign matter and moisture prior to pulling wire and cable. All boxes in which conduits terminate shall be cleaned of all concrete mortar and other foreign matter.

U. Provide #30 nylon pulling line in all conduits in which permanent wiring is not installed.

V. All conduit shall be securely fastened and supported using hot galvanized malleable iron one-hole pipe straps, clamps, hanger or other means approved by the engineer. Supports shall be as required per NEC. Tie wire shall not be used as support or securing means. Support conduit independently of ceiling hanger wire. Use all thread rods to support outlet boxes, junction boxes and conduit.

W. Contact the Architect and Engineer for an installation review before covering any below grade or above grade conduit.

X. All new outlets shall be flush mounted. In remodeled areas where wall construction prohibits flush mounting, provide Hubbell 2400 series, unless noted otherwise. Verify exact location and routing with architect before installation.

Y. Contractor shall not penetrate waterproof barriers without using proper fitting to maintain barriers. This shall include exterior walls and slabs. Coordinate with Architect for proper methods.

3.2 CONDUIT ROUTING

A. Conduit shall be concealed and by using the shortest practicable route between outlets, including where located on CMU walls.

B. Conduit may be exposed in electrical and mechanical rooms, and central plants, or other industrial type facilities such as warehouses or production plants.

C. Conduit may be installed as exposed where added by renovation – only where walls are not added or renovated. Otherwise, exposed conduit is not accepted.

D. Install risers, drops, offsets to avoid ductwork and structural components. Ductwork and structural systems shall take precedence to conduit.

E. Any exposed and visible conduit shall be parallel and perpendicular based on the lines of the building (such as ceiling lines, wall blocking lines, or architectural feature lines) using structural systems to conceal conduit visibility at all opportunities.

F. Concealed conduit shall be run in as direct manner as possible, using long bends. All bend radii shall be 12x conduit diameter. Condulets in lieu of elbows where ease of installation and appearance warrant their use – confirmation with architect is required for this use.

G. Conduit shall be continuous, with no more than (4) quarter bends between terminals, cabinets, boxes, or pullboxes is acceptable. Contractor is expected to provide wireway or boxes at appropriate intervals, in accordance with NFPA 70 for wire bending space. All conduit shall be electrically continuous throughout, including across boxes and cabinets. Terminals of all conduit shall be provided with double lock nuts and bushing, or terminated on conduit hubs. Use of Running Threads prohibited.

3.3 CONDUIT CORROSION PROTECTION

A. Branch circuit conduits installed in concrete slabs on fill or grade shall be positioned in a manner to ensure complete concrete cover. In no case shall such conduits be exposed below or above the slab surfaces, or penetrate the waterproof membrane.

B. At locations where metallic conduits pass through slabs on grade or transitions below grade, PVC coated rigid galvanized conduit shall be used.

C. Conduit installed in the air gap between the water-resistant barrier and finish brick shall not exceed 2-ft. in length.

3.4 EXPANSION JOINTS

A. Install approved expansion fitting in all conduit runs in excess of 150 feet or when crossing building expansion joints.

3.5 OUTLET AND JUNCTION BOXES

A. Provide an approved galvanized outlet box with adequate volume for number of conductors installed.

B. Provide standard galvanized switch boxes of the required number of gangs. Switch boxes where conduit is exposed shall be handy boxes or approved equal.

C. Outlet boxes for receptacles shall be similar to Universal 52151 with suitable raised cover. Receptacle boxes where conduit is exposed shall be handy boxes or approved equal.

D. Weatherproof boxes shall be FS or FD. Provide these boxes in all non-conditioned areas, exterior areas and natatoriums.

E. Outdoor boxes shall be NEMA 3R, with conduit connections made by Myers Hubs.

F. See notes and details on Drawings for special box requirements.

G. Provide junction boxes required to facilitate installation of the various conduit systems. Provide support boxes required for risers, each complete with approved cable supports as described elsewhere in this Division.

H. Outlet boxes for drywall shall be standard galvanized 4" square boxes with the appropriate device cover. Secure all outlet boxes with a backing brace connected to two adjacent studs. Mounting brackets with a single ear to rest against the backing sheet rock are not acceptable.

I. Provide floor outlet fittings for telephone to match fittings for duplex floor receptacles.

J. Provide 3-1/2” deep gangable masonry boxes in all masonry wall (CMU). Steel City GW-135-G or approved equal.

K. Provide shallow 4”x4” boxes in all demountable partitions.

L. Metallic boxes located in fire rated walls or partitions shall be separated by a minimum horizontal distance of 24 in. This minimum separation distance between metallic boxes may be reduced when “ Wall Opening Protective Materials” (CLIV) are installed according to the requirements of their Classification. Metallic boxes shall not be installed on opposite side of walls or partitions of staggered stud construction unless “Wall Opening Protective Materials” are installed with the metallic boxes in accordance with Classification requirements for the protective materials.

M. Junction, pull boxes, condulets, gutters, disconnects, contactors, etc., above 2-foot x 2-foot grid ceilings shall be mounted within 18-inches of ceiling grid. Above 2-foot x 4-foot grid ceiling they shall be mounted within 30-inches of ceiling grid. All junction box, pull box, gutter openings shall be side or bottom accessible.

N. Junction boxes are prohibited above drywall or plaster ceilings except for lighting; and those must be mounted directly over light fixture opening. Route power, PA, fire alarm conduits to nearest lay-in ceiling.

3.6 THRU-WALL SEALS

A. Provide O.Z. Gedney “Thru-wall” seals for all conduits passing through concrete structure below grade, above grade, and floor penetrations below grade. These prevent moisture from entering the building.

B. Straight sleeves are not acceptable.

3.7 PULL BOXES

A. Interior Pull boxes shall be provided for conduit systems as required and shall be constructed of galvanized steel of not less than gauge and size specified by National Electrical Code. Size pull boxes per Article 314.28 - NFPA 70.

B. Where two or more feeders pass through a common pull box, they shall be tagged to indicate clearly their electrical characteristics, circuit number, and panel designation.

C. Exterior in-ground pull boxes shall have open bottoms with sand and rock beds below box for drainage of water. Provide closed bottom boxes where specified. Closed bottom boxes shall be provided with sumps for portable pump to allow for extracting water. Refer to details on the drawings.

D. Pull boxes mounted in pole bases shall be coordinated with the pour of the pole base and shall be flush with finished footing.

3.8 WIREWAYS

A. Wireways shall be installed as indicated or required and locations shall be coordinated with architect.

B. Wiring in wireways shall be neatly bundled, tied and suitably tagged.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract Documents, including General and Supplementary Conditions and Division 01 Specifications, apply to this section.

1.2 RELATED SECTIONS

A. Section 01 91 00 - General Commissioning Requirements

B. Section 23 09 63 - Energy Management and Control System (EMCS)

1.3 SUMMARY

A. The commissioning of the lighting system and associated controls as well as the service and distribution equipment shall be performed by an impartial technical firm hired by the owner or shall be performed by the installing contractor if the owner has not hired a commissioning firm. The commissioning provider shall be certified under one or more of the following certifications:

1. CxA - Certified Commissioning Authority - ACG
2. CBCP - Certified Building Commissioning Professional - AEE
3. CCP - Certified Commissioning Professional - BCA
4. CPMP - Certified Process Management Professional - ASHRAE
5. BSC - Building System Commissioning Certification - NEBB

B. The commissioning provider (Commissioning authority) shall be responsible for leading the entire construction team through the commissioning process including, but not limited to, conducting the commissioning kick-off meeting, preparing the commissioning plan, preparing pre-functional checklists, preparing functional test scripts, participation in functional testing and preparation of required documentation and reports.

1.4 RESPONSIBILITIES

A. Contractor: Responsibilities of the Contractor as relate to Commissioning Process include, but are not limited to the following:

1. Facilitate coordination of Commissioning work by Commissioning authority.
2. Attend Commissioning meetings or other meetings called by Commissioning authority to facilitate the Commissioning Process.
3. Review Functional Performance Test procedures for feasibility, safety, and impact on warranty, and provide Commissioning authority with written comment on same.

4. Provide all documentation relating to manufacturer's recommended performance testing of equipment and systems.

5. Provide Operations & Maintenance data to Commissioning authority for preparation of checklists and training manuals.

6. Provide As-built drawings and documentation to facilitate Testing.

7. Assure and facilitate participation and cooperation of Sub Contractors and equipment suppliers as required for the Commissioning Process.

8. Certify to Commissioning authority that installation work listed in Pre-Functional Checklists has been completed.

9. Install systems and equipment in strict conformance with project specifications, manufacturer's recommended installation procedures, and Pre-Functional Checklists.

10. Provide data concerning performance, installation, and start-up of systems.

11. Provide copy of manufacturers filled-out start-up forms for equipment and systems.

12. Ensure systems have been started and fully checked for proper operation prior to arranging for Testing with Commissioning authority. Prepare and submit to Commissioning authority **written** certification that each piece of equipment and/or system has been started according to manufacturer's recommended procedure, and that system has been tested for compliance with operational requirements.

    a. Contractor shall carry out manufacturer's recommended start-up and testing procedures, regardless of whether or not they are specifically listed in Pre-Functional Checklists.

    b. Contractor is not relieved of obligation for systems/equipment demonstration where performance testing is required by specifications, but a Functional Performance Test is not specifically designated by Commissioning authority.

13. Coordinate with Commissioning authority to determine mutually acceptable date of Functional Performance Tests.

14. Provide qualified personnel to assist and participate in Commissioning.

15. Provide test instruments and communications devices, as prescribed by Commissioning authority, required for carrying out Testing of systems.

16. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process. Proprietary test equipment shall become the property of the Owner upon completion of commissioning.

17. Ensure deficiencies found in the Commissioning Issues Log are corrected within the time schedule shown in the Commissioning Plan.

18. Provide Commissioning authority with all submittals, start-up instructions manuals, operating parameters, and other pertinent information related to Commissioning Process. This information shall be routed through Architect.

19. Provide commissioning authority with a certificate of readiness to show systems are ready to schedule functional testing.

20. Prepare and submit to Commissioning authority proposed Training Program outline for each system.

21. Coordinate and provide training of Owner's personnel.

22. Prepare Operation & Maintenance Manuals and As-Built drawings in accordance with specifications; submit copy to Commissioning authority in addition to other contractually required submissions. Revise and resubmit manuals in accordance with Design Professionals and Commissioning authority's comments.

23. Commissioning requires participation of this Division Subcontractors to ensure that systems are operating in manner consistent with Contract Documents. All costs associated with the participation of Contractor, Sub-Contractors, Design Professionals, and Equipment Vendors in the Commissioning Process shall be included as part of the Construction Contract.

B. Subcontractors and vendors shall prepare and submit to Commissioning Agent proposed Startup procedures to demonstrate proper installation of systems, according to these specifications and checklists prepared by Commissioning authority.

C. Electrical contractor shall provide a letter certifying the installed lighting controls meet documented performance criteria specified in the commissioning plan within 90 days of substantial completion.

1.5 COMMISSIONING PLAN

A. Commissioning Process tasks and activities:

1. Commissioning kick-off meeting: Conducted by commissioning authority and attended by construction team and design team.

2. Pre-functional checklists: Prepared by the commissioning authority and filled out by subcontractors performing the work that is applicable.

3. Site visits to review installation of applicable systems and progress of checklist documentation performed and reported by commissioning authority.

4. Functional testing: Commissioning authority shall conduct functional testing with assistance of applicable subcontractors and document successful results as well as deficiencies (issues). Functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing in accordance with plans and specifications.

5. Preliminary commissioning report: Commissioning authority shall issue a preliminary commissioning report to the owner that has results of the first round of functional testing including deficiencies discovered.

6. Systems manual: Commissioning authority shall compile the systems manual using submittal data provided by the general contractor and applicable subcontractors.

7. Final commissioning report: Commissioning authority shall issue final commissioning report documenting the entire process and final results of functional testing. Report shall include final testing and balancing report.

B. Electrical System Equipment to be tested

1. Electrical Service and Distribution System.

C. Testing functions and conditions

1. Electrical Service and Distribution System

a. Document the ground resistance testing performed by contractors.

b. Document electrical subcontractor has adjusted breakers to setting recommended by coordination study.

c. Document that any required infrared studies are performed.

d. Document testing of transformer insulation and voltage drop.

e. Document any other testing requirements have been fulfilled as required within specifications.

D. Performance criteria

1. Daylighting controls shall maintain specified light levels within 5% of design.

2. All time switches shall be accurate to time on cellular network devices.

PART 2 - PRODUCTS

2.1 NO PRODUCTS SUPPLIED

PART 3 - EXECUTION

3.1 GENERAL

A. This Division has startup responsibilities and are required to complete sub-systems so COMPLETE SYSTEMS are fully functional. Insuring they meet design requirements of Contract Documents. Commissioning procedures and testing do not relieve or lessen this responsibility or shift this responsibility, in whole or in part, to Commissioning Agent or Owner.

B. Coordinate with other Sub-Contractors and equipment vendors to set aside adequate time to address Pre-Functional Checklists, Functional Performance Tests, Operations & Maintenance Manual creation, Owner Training, and associated coordination meetings.

C. Commissioning authority will also conduct site inspections at critical times and issue Cx Field Reports with observations on installation deficiencies so that they may be issued by Architect as deemed appropriate.

3.2 WORK PRIOR TO COMMISSIONING

A. Complete all phases of the work so the systems can be started, adjusted, balanced and otherwise tested.

B. See pertinent specification sections in this Division, which outline responsibilities for start-up of equipment with obligations to complete systems, including all sub-systems so that they are fully functional.

C. Assist Commissioning Agent with all information pertaining to actual equipment and installation as required complete the full commissioning scope.

D. Contractor shall prepare startup procedures to demonstrate compliance with pre-functional checklists, and coordinate scheduling for completion of these checklists.

E. A minimum of seven (7) days prior to date of system startup, submit to Commissioning Agent for review, detailed description of equipment start-up procedures which contractor proposes to perform to demonstrate conformance of systems to specifications and Checklists.

3.3 PARTICIPATION IN COMMISSIONING

A. Attend meetings related to the Commissioning Process; arrange for attendance by personnel and vendors directly involved in the project, prior to testing of their systems.

B. Provide skilled technicians to startup and test all systems, and place systems in complete and fully functioning service in accordance with Contract Documents.

C. Provide skilled technicians, experienced and familiar with systems being commissioned, to assist Commissioning authority in commissioning process.

3.4 WORK TO RESOLVE DEFICIENCIES

A. Complete corrective work in a timely manner to allow expeditious completion of Commissioning Process. If deadlines pass without resolution of identified problems, Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs thus incurred will be Contractor’s responsibility.

3.5 PRE-FUNCTIONAL CHECKLISTS (PFC)

A. Contractor shall complete Pre-Functional Checklists to validate compliance with Contract Documents installation and start-up requirements, for this Division’s systems.

B. Refer to commissioning plan for detailed list of equipment to be commissioned.

3.6 FUNCTIONAL PERFORMANCE TESTING (FPT)

A. Contractor, in cooperation with Commissioning Agent, shall conduct Functional Performance Testing to validate compliance with Contract Documents.

B. Refer to commissioning plan for detailed list of equipment to be commissioned.

C. Provide commissioning authority with a certificate of readiness to show systems are ready to schedule functional testing.

D. Assist Commissioning authority in Functional Testing by removing equipment covers, opening access panels, etc. Furnish ladders, flashlights, meters, gauges, or other inspection equipment as necessary.

E. Sampling

1. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy.

2. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in pre-functional checklist execution.

3. A common sampling strategy is the “xx% Sampling - yy% Failure Rule”, defined by the following example.

a. xx = the percent of the group of identical equipment to be included in each sample.

b. yy = the percent of the sample that if failing, will require another sample to be tested.

c. The example below describes a 20% Sampling - 10% Failure Rule.

d. Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample.”

e. If 10% (yy) of the units in the first sample fail the functional tests, test another 20% of the group (the second sample).

f. If 10% of the units in the second sample fail, test all remaining units in the whole group.

g. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

F. Re-Testing And Failure To Remedy Deficiencies

1. Despite Contractor's best efforts to ensure systems are problem-free, it is expected that some deficiencies will be found during initial inspection of Pre-functional Checklist, and during initial Functional Testing; such deficiencies are expected to be minimal.

2. It is Contractor's responsibility to remedy identified deficiencies, both in Pre-functional Checklist and in Functional Testing phases of work, in a timely and thorough manner.

3. It is Contractor's responsibility to ensure that all deficiencies are corrected prior to requesting a re-inspection or re-test of systems and equipment. Do not request re-inspection or re-test until deficiencies are corrected.

    a. At his discretion, CxA may agree to re-testing systems or equipment where deficiencies remain which are beyond Contractor's control to resolve expeditiously.

    b. Typically such re-testing of incomplete systems and equipment will take place only if remaining deficiencies are minor in scope and nature, and are of such nature that they cannot be resolved in a timely manner (such as those due to difficulties in obtaining parts, or where Owner has requested a change that has delayed work, etc.)

4. CxA will carry out a second re-inspection or re-test of systems and equipment subsequent to receiving Contractor's request.

    a. If CxA finds deficiencies identified in initial inspection or test have not been remedied (with exception of un-resolvable deficiencies in 3.b. above), and such remaining deficiencies are significant enough to require additional inspection or re-testing, Contractor will be back-charged for CxA's expenses, and time at a rate of $150.00 per hour and $100.00 expenses, for a third and any subsequent re-inspections and re-tests.

G. Deferred Testing

1. "Seasonal Commissioning" pertains to testing during peak heating or cooling seasons when HVAC equipment is operating at full-load or heavy-load conditions. Initial commissioning will be done as soon as contract work is completed, regardless of season. Seasonal Commissioning under full- or heavy-load conditions other than the current season will be handled at later time by GC and CxA.

2. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods.

3. GC is to provide services of personnel and participate in seasonal testing process in the same manner as he would in non-seasonal testing.

4. Until off-season commissioning can be accomplished, Owner may retain an amount from GC's payment sufficient to cover the cost of off-season testing.

5. Unforeseen Deferred Tests: If any check or test cannot be completed due to building structure, required occupancy condition, or other reason, execution of checklists and functional testing may be delayed upon approval of Owner. Tests shall be conducted in same manner as seasonal tests, as soon as possible. Services of required parties will be negotiated. Make final adjustments to Operation and Maintenance Manuals and record drawings due to unforeseen deferred tests.

6. GC is to provide services of personnel and participate in deferred testing in the same manner as he would for normal commissioning.

3.7 TRAINING

A. The following requirements are in addition to Operations & Maintenance requirements specified elsewhere in this specifications manual.

B. Contractor shall be responsible for training coordination and scheduling, and ultimately to ensure that training is completed.

C. The training agenda (plan) shall include, at a minimum, the following elements:

1. Purpose of equipment.

2. Principle of how the equipment works.

3. Important parts and assemblies.

4. How the equipment achieves its purpose and necessary operating conditions.

5. Most likely failure modes, causes and corrections.

6. On site demonstration.

D. Commissioning Agent shall be responsible for overseeing and approving content and adequacy of training of Owner personnel for all installed systems. Provide Commissioning Agent with training plan two weeks before planned training.

3.8 OPERATIONS & MAINTENANCE MANUALS

A. The following requirements are in addition to Operations & Maintenance requirements specified elsewhere in this specifications manual.

B. Contractor shall compile and prepare documentation for equipment and systems specified in this Division, and shall deliver documentation to Contractor for inclusion in Operation & Maintenance Manuals, in accordance with requirements of Division 01, prior to training Owner personnel.

C. Provide Commissioning authority with a single, electronic copy of Operation & Maintenance Manuals for review. Commissioning authority’s copy of O&M manuals shall be submitted through Architect.

D. Operation and maintenance manuals shall include, service agency contact information, maintenance requirements, controls system settings and a narrative of how each system is intended to operate, including set points.

3.9 DOCUMENTATION

A. Commissioning authority shall provide documentation of process as follows:

1. Preliminary commissioning report including test procedures, results of testing, itemization of deficiencies, deferred tests and climatic conditions required for performance of deferred tests. Preliminary commissioning report shall be issued to owner to demonstrate the first pass of testing has occurred and to demonstrate compliance with applicable codes.

2. Final commissioning report shall include the final test and balance report, final results of functional testing, disposition of deficiencies discovered during testing, including the details of corrective measures used and functional testing procedures used for repeatability of testing in the future.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. Provide wiring devices as shown, scheduled, required and as specified.

B. The types of wiring devices required include:

1. Switches

2. Receptacles

1.2 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2017g (Validated 2023).

C. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).

D. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

G. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

H. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

I. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.3 QUALITY ASSURANCE

A. All wiring devices shall comply with NEMA WD 1 and NEMA WD 6 as well as FS W-C-596 and FS W-S-896 as applicable.

B. All switches shall comply with UL 20 as applicable.

C. All receptacles shall comply with UL 498 as applicable.

D. All GFCI receptacles shall comply with UL 943.

E. All AFCI receptacles shall comply with UL 1699.

1.4 ACCEPTABLE MANUFACTURERS

A. Hubbell

B. Leviton

C. Pass & Seymour

1.5 SUBMITTALS

A. Shop drawings shall include but not be limited to:

1. Cut sheets of all devices indicating NEMA configuration, rating, materials, color, and all accessories.

2. Cut sheets of all coverplates indicating materials, color and any engraving specified on drawing or in the specifications.

1.6 REQUIREMENTS OF REGULATORY AGENCIES WORK IN ACCORDANCE WITH

A. National Electric Code.

B. Local, municipal, or state codes that have jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. GENERAL

1. Provide factory assemble wiring devices with the rating type and color as required and specified for the service indicated.

2. Provide matching one-piece multiple gang plates where switches are ganged.

3. Provide wall plates for each receptacle furnished.

4. Architect reserves the right to select wiring device styles and colors to match wall finish.

5. Wall plates shall be of same manufacturer as devices.

2.2 SWITCHES

A. Provide specification grade White toggle switches where indicated on the Drawings. Provide "Red" switches for switching emergency lighting circuits where switching is indicated. Coordinate exact locations with architect.

1. Wall switches shall be 20 amp, 120-277 volt and shall be Hubbell, Leviton or P&S as follows:

TOGGLE SWITCHES	HUBBELL	LEVITON	P&S
SINGLE POLE	HBL1221	1221-2	PS20AC1
DOUBLE POLE	HBL1222	1222-2	PS20AC2
THREE WAY	HBL1223	1223-2	PS20AC3
FOUR WAY	HBL1224	1224-2	PS20AC4
MOMENTARY CONTACT	HBL1557	1257	1251

THREE POSITION, TWO CIRCUIT MAINTAINED CONTACT	HBL1385	1285	1225
KEY TYPE LOCKABLE BARREL KEY OR CORBIN STYLE	HBL1221-RKL	1221-2KL	PS20AC1-KL
PROVIDE WITH EXTRA KEYS	HBL1209RKL	2KL	4609
DISCONNECT SWITCH / INSTA HOT	HBL7810DS	MS303-DSS	7803

2. Dwelling units shall use Hubbell CS115I, CS120I, P&S CS15AC1, and CS20AC1.

3. Dimmers: Provide Lutron DIVA or equal as shown on drawings. Wall box dimmers shall be sized to handle the load served. Provide phase dimmers to control LED lamps when 0-10 volt dimming drivers are not provided.

4. Light Handle Switches: Provide Hubbell HBL1221-IL, Leviton 1221-LHC, P&S PS20AC1-ISI lighted handles to switch emergency lights where noted on the drawings.

B. Provide specification grade White decora style rocker switches where indicated on the Drawings. Provide "Red" switches for switching emergency lighting circuits where switching is indicated. Coordinate exact locations with architect.

1. Wall switches shall be 20 amp, 120-277 volt and shall be Hubbell Decorator Series, Leviton, Decora or Pass & Seymor Decorator, as follows:

ROCKER/DECORATOR SWITCHES	**HUBBELL**	**LEVITON**	**P&S**
SINGLE POLE	DS120	5621-2	2621
DOUBLE POLE	DS220	5622-2	2622
THREE WAY	DS320	5623-2	2623
FOUR WAY	DS420	5624-2	2624
MOMENTARY CONTACT	HBL1557	1257	1251
THREE POSITION, TWO CIRCUIT MAINTAINED CONTACT	HBL1385	1285	1225
KEY TYPE LOCKABLE BARREL KEY OR CORBIN STYLE	HBL1221-RKL	1221-2KL	PS20AC1-KL
PROVIDE WITH EXTRA KEYS	HBL1209RKL	2KL	4609
DISCONNECT SWITCH / INSTA HOT	HBL7810DS	MS303-DSS	7803

2. Dimmers: Provide Lutron DIVA or equal where required. Wall Box dimmers shall be sized to handle the load. Provide Phase dimmers to control LED lamps when 0-10V drivers are not provided.

3. Light Handle Switches: Provide Leviton 5649-2 or P&S 2625 lighted handles to switch emergency lights where noted on the drawings.

2.3 RECEPTACLES

A. Provide specification grade White receptacles where indicated on the drawings. Provide “Red” receptacles for receptacles on emergency power. Coordinate exact location with architect.

1. Receptacles shall be Hubbell, Leviton or Pass & Seymour as follows:

CONVENTIONAL RECEPTACLES	HUBBELL	LEVITON	P&S
HEAVY DUTY BRASS MOUNTING YOKE NEMA 5-20R DUPLEX	HBL5352	5362	5362
HEAVY DUTY BRASS MOUNTING YOKE NEMA 5-20R SIMPLEX	HBL5361	5361	5361
ISOLATED GROUND 20A, 125V ORANGE NEMA 5-20R DUPLEX	IG5352	5362IG	IG5362
CLOCK HANGER 15A-125V BROWN WITH STAINLESS STEEL PLATE WITH HANGER	HBL5235	5361-CH	S3733-SS
GFCI DUPLEX 20A, 125V SELF TESTING, FEED THRU CAPABLE, TAMPER RESISTANT FOR LOCATIONS REQUIRING TAMPER RESISTANT INSTALLATION OR AS INDICATED ON THE DRAWINGS	GFRST20	GFTR2	2097TR
GFCI DUPLEX 20A, 125V SELF TESTING, FEED THRU CAPABLE, TAMPER/WEATHER RESISTANT FOR INSTALLATION IN DAMP/WET LOCATION OR AS INDICATED ON THE DRAWINGS	GFTWRST20	GFWR2	2097TRWR
HEAVY DUTY TAMPER RESISTANT BRASS MOUNTING YOKE	HBL5362WTR	5362-SG	---
TAMPER RESISTANT 20A, 125V DUPLEX	BR20WHITR	8300-SG	TR63-H
SURGE PROTECTION 20A, 125V DUPLEX, BLUE NEMA 5-20R WITH AUDIBLE ALARM	HBL5362SA	7380-B	5362SP
USB CHARGER TYPE DUPLEX 20A, 125V TAMPER RESISTANT, ONE USB TYPE A PORT, ONE USB TYPE C PORT. MIN. OF 5A USB OUTPUT.	USB20AC5 5A OUTPUT	T5833 5.1A OUTPUT	TR20USBAC6 A OUTPUT
USB CHARGER TYPE DUPLEX 20A, 125V TAMPER RESISTANT, ONE HIGH OUTPUT POWER DELIVERY USB TYPE C PORT, ONE STANDARD USB TYPE A PORT.	USB20ACPD 20V, 55W TYPE C; 5V, 1.5A TYPE A	T5834 20V, 50W TYPE C; 5V, 2A TYPE A	---
PLUG LOAD CONTROLLED RECEPTACLES 20A, 125V TAMPER RESISTANT WITH TWO CONTROLLED FACES	BR20C2WHITR	TBR20-S2W	TR5362CDW

PLUG LOAD CONTROLLED RECEPTACLES 20A, 125V TAMPER RESISTANT WITH ONE CONTROLLED FACE	BR20C1WHITR	TBR20-S1W	TR5362CHW
ARC FAULT CIRCUIT INTERRUPTER RECEPTACLES	AF20TRW	AFTR2-W	AF202TRW
GROUND FAULT CIRCUIT INTERRUPTER / ARC FAULT DUAL FUNCTION	AFGF20TR	AGTR2-W	AFGF202TR

B. Provide specification grade, Decora type White receptacles where indicated on the drawings. Provide “Red” receptacles for receptacles on emergency power. Coordinate exact location with architect.

1. Receptacles shall be Hubbell, Leviton, or Pass & Seymour as follows:

DECORATOR / DECORA RECEPTACLES	HUBBELL	LEVITON	P&S
DECORATOR DUPLEX 20A, 125V NEMA 5-15R SELF GROUNDING	DR20	16362	26342
DECORATOR SIMPLEX 20A, 125V NEMA 5-15R SELF GROUNDING	---	1635	26361
ISOLATED GROUND DUPLEX 20A, 125V ORANGE NEMA 5-20R	IG20DRx	16362-IG	IG26362
CLOCK HANGER 15A-125V BROWN WITH STAINLESS STEEL PLATE WITH HANGER	HBL5235	5361-CH	S3733-SS
GFCI DUPLEX 20A, 125V SELF TESTING, FEED THRU CAPABLE, TAMPER RESISTANT FOR LOCATIONS REQUIRING TAMPER RESISTANT INSTALLATION OR AS INDICATED ON THE DRAWINGS	GFRST20	GFTR2	2097TR
GFCI DUPLEX 20A, 125V SELF TESTING, FEED THRU CAPABLE, TAMPER/WEATHER RESISTANT FOR INSTALLATION IN DAMP/WET LOCATION OR AS INDICATED ON THE DRAWINGS	GFTWRST20	GFWR2	2097TRWR
TAMPER RESISTANT DUPLEX 20A, 125V NEMA 5-20R	DR20WHITR	16362-SG	TR26362
SURGE PROTECTION 20A, 125V DUPLEX, BLUE NEMA 5-20R WITH AUDIBLE ALARM	HBL5362SA	7380-W	5362SP
USB CHARGER TYPE DUPLEX 20A, 125V TAMPER RESISTANT, ONE USB TYPE A PORT, ONE USB TYPE C PORT. MIN. OF 5A USB OUTPUT.	USB20AC5 5A OUTPUT	T5833 5.1A OUTPUT	TR20USBAC6 6A OUTPUT
USB CHARGER TYPE DUPLEX 20A, 125V TAMPER RESISTANT, ONE HIGH	USB20ACPD 20V, 55W	T5834 20V, 50W	---

OUTPUT POWER DELIVERY USB TYPE C PORT, ONE STANDARD USB TYPE A PORT.	TYPE C; 5V, 1.5A TYPE A	TYPE C; 5V, 2A TYPE A	
PLUG LOAD CONTROLLED RECEPTACLES 20A, 125V TAMPER RESISTANT WITH TWO CONTROLLED FACE	DR20C2WHITR	16352-2PW	TR26362CDW
PLUG LOAD CONTROLLED RECEPTACLES 20A, 125V TAMPER RESISTANT WITH ONE CONTROLLED FACE	DR20C1WHITR	16352-1PW	TR26362CHW
ARC FAULT CIRCUIT INTERRUPTER RECEPTACLES	AF20TRW	AFTR2-W	AF202TRW
GROUND FAULT CIRCUIT INTERRUPTER / ARC FAULT DUAL FUNCTION	AFGF20TR	AGTR2-W	AFGF202TR

2.4 COVERPLATES

A. Furnish and install coverplates on all outlet boxes. Oversize (Jumbo) coverplates are not acceptable.

B. Coverplates shall be smooth nylon and 302/304 smooth stainless steel in kitchen and coffee bar areas.

C. Provide Hubbell WP Series, Bell, Carlon or Leviton NEMA 3R weatherproof coverplates on all exterior wiring devices. Enclosure shall be suitable for wet locations when in use.

D. Coverplates shall be Hubbell SS Series, Leviton, Pass & Seymour 302/304 smooth stainless steel on all receptacles 30 amps and larger.

E. Stainless steel device plates shall be provided at locations with tile or stone walls.

PART 3 - EXECUTION

3.1 WIRING DEVICE MOUNTING HEIGHTS

A. Unless noted to the contrary on plans, or directed otherwise during the progress of the Work, wiring devices shall be set as follows:

1. Switches 42" above finished floor.

2. Wall mounted receptacles shall be installed vertically at 15 inches to the bottom outlet above finished floor unless otherwise noted or as required by local codes.

3. Wall telephone outlets shall be mounted 15 inches to the bottom above finished floor unless otherwise noted. Mount even with wall mounted receptacles.

4. At locations above counters, set devices at 6 inches above to the centerline counter tops, verify exact mounting height with the architect.

3.2 INSTALLATION (REFER TO 26 05 33 FOR OUTLET BOX SPECIFICATIONS)

A. Wall switches shall be set in a suitable steel box and shall be installed on the strike side of the door as finally hung, whether so indicated on the Drawings or not.

B. Receptacles shall be installed in a suitable steel box.

C. The Architect reserves the right to relocate wiring device up to a distance of 5 feet from the location shown, before rough-in, without additional cost.

D. Provide multi-gang device covers at locations where devices gang together.

E. Device locations are indicated schematically on the drawings along with the type and mounting height. Final locations and mounting heights shall be coordinated with the Architect on the jobsite, and with shop drawings of equipment; including equipment to be furnished and installed by the Owner. Devices installed in walls covered with vinyl, fabric wallpaper or other special finishes shall be coordinated and verified with the Architect on the job site.

F. Stranded wire termination to switches, receptacles, devices and miscellaneous control devices shall be with an approved solderless terminal if clamp type securing is not possible (i.e. Sta-Con crimp on fork tongue connectors; Burndy Type TP-F).

G. Provide keyed switches in all common areas not monitored by the faculty (i.e. gym, corridors, cafeteria, commons natatoriums).

H. All 15 amp and 20 amp receptacles shall be tamper-resistant type.

I. All 20A, 120V receptacles in food service areas shall be GFCI.

J. Provide GFCI circuit breakers for all drinking fountain branch circuits where GFCI receptacles are not indicated on plan.

K. Provide ARC Fault circuit interrupters (AFCI) as required to comply with article 210.12 of NFPA 70. This shall include but not be limited to dwelling units and dormitories. AFCI breakers may be used.

L. Provide ground fault circuit interrupter (GFCI)/ARC Fault circuit interrupter (AFCI) dual function receptacles to comply with articles 210.8, 210.12 and 406.4 of NFPA 70.

M. Provide high output model for USB receptacles for applications where end user charging time is of high priority or where specifically indicated on the drawings. Provide standard output USB receptacles for all other applications.

N. Contractor shall indicate the circuit serving each wiring device. Provide a typewritten label located on the inside face of the coverplate for all recessed mounted devices and on the outside of the coverplate on all surface mounted devices.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SCOPE

A. Provide fuses as shown and scheduled and indicate by this specification section and other specifications sections.

B. The type of fuses include:

1. 600 volt current limiting.

2. 250 volt current limiting.

1.2 STANDARDS

A. ANSI

B. UL

1.3 ACCEPTABLE MANUFACTURERS

A. Eaton Bussmann

B. Mersen

1.4 SUBMITTALS

A. Shop drawings shall include, but not be limited to:

1. Cutsheets of all fuses showing ratings and fuse curves.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. WORK IN ACCORDANCE WITH:

1. National Electrical Code.

2. Local, municipal, or state codes that have jurisdiction.

PART 2 - PRODUCTS

2.1 CURRENT - LIMITING FUSES

A. General: Provide 200,000 amp interrupting capacity current limiting fuses of the ampacity and voltage indicated and scheduled.

B. Mains, Feeders and Branch Circuits

1. Circuits 601 to 6000 ampere shall be protected by current limiting BUSSMANN HI-CAP Time Delay Fuses KRP-C. Fuses shall employ "O" ring as positive seals between the end bells and the glass melamine fuse barrel. The terminals shall be peened. Fuses shall be time-delay and must hold 500% of rated current for a minimum of 4 seconds, clear 20 times rated current in .1 seconds or less and be listed by Underwriters` Laboratories Inc., with an interrupting rating of 200,000 amperes r.m.s. symmetrical. The fuses shall be UL Class L.

C. Class J Fuses

1. Circuits 0 to 600 ampere shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses LPJ. All dual-element fuses shall have separate overload and short-circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284 degree Fahrenheit melting point alloy and shall be independent of the short-circuited clearing chamber. The fuse must hold 500% of rated current for a minimum of 10 seconds and listed by Underwriters' Laboratories Inc., with an interrupting rating of 200,000 amperes rRMS symmetrical. The fuses shall be UL Class J.

2. Motor Circuits - All individual motor circuits rated 600 amperes or less shall be protected by BUSSMANN LOW-PEAK LPJ. The fuses for 1.15 service factor motors shall be installed in ratings approximately 125% of motor full current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the motor full load current. Larger H.P. Motor shall be protected by BUSSMANN Type KRP-C HI-CAP Time-Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element Fuses LPJ installed in ratings approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class LPJ or L. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual-Element LPJ as shown on the drawings. The fuses shall be UL Class J.

D. Class RK1 Fuses

1. Circuits 0 to 600 ampere shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses LPN-RK (250 volts) or LPS-RK (600 volts). All dual-element fuses shall have separate overload and short-circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284 degree Fahrenheit melting point alloy and shall be independent of the short-circuited clearing chamber. The fuse must hold 500% of rated current for a minimum of 10 seconds and listed by Underwriters' Laboratories Inc., with an interrupting rating of 200,000 amperes RMS symmetrical. The fuses shall be UL Class RK1.

2. Motor Circuits - All individual motor circuits rated 600 amperes or less shall be protected by BUSSMANN LOW-PEAK Dual Element Fuses LPN-RK (250 volts) or LPS-RK (600 volts). The fuses for 1.15 service factor motors shall be installed in ratings approximately 125% of motor full current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the motor full load current. Larger H.P. Motor shall be protected by BUSSMANN Type KRP-C HI-CAP Time-Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element Fuses LPN-RK (250 volts) or LPS-RK (600 volts) installed in ratings approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class RK1 or L.

3. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual-Element LPN-RK (250 volts) or LPS-RK (600 volts) as shown on the drawings. The fuses shall be UL Class RK1.

2.2 SPARES

A. Upon completion of the building the contractor shall provide the owner with spare fuses as shown below.

1. 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares.

2. BUSSMANN spare fuse cabinets - Catalog No. SFC - shall be provided to store the above spares.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuses: Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job-site or from installation. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer.

B. All fuses shall be installed in fuse holders.

END OF SECTION

SECTION 26 28 16 - SAFETY AND DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SCOPE

A. Provide safety and disconnect switches as shown, scheduled and as specified herein.

1.2 STANDARDS

A. Products shall be designed, manufactured, tested and installed in compliance with applicable standards.

1. NEMA KS1 - Enclosed switches

2. Federal specification W-S-865C-Heavy duty switches

B. Products shall conform all applicable UL standards, including UL98 (standard for safety, enclosed and dead front switches) and shall be UL-labeled.

1.3 ACCEPTABLE MANUFACTURERS

A. Provide one of the following manufacturers:

1. General Electric Company/ABB

2. Square D Company

3. Siemens

4. Eaton

1.4 SUBMITTALS

A. Shop drawings shall include, but not be limited to:

1. Cutsheets of switches with ratings, physical dimensions and all accessories clearly labeled.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. WORK IN ACCORDANCE WITH:

1. National Electrical Code.

2. Local, municipal, or state codes that have jurisdiction.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install heavy duty type safety switches with the number of switched poles as indicated on the plans and specifications. All safety switches shall be NEMA Heavy Duty Type HD, and Underwriters Laboratories listed.

2.2 MATERIALS AND COMPONENTS

A. Switch Interior

1. All switches shall have switch blades that are fully visible in the "OFF" position when the door is open. Switches shall have removable arc suppressor where necessary, to permit easy access to line side lugs. Lugs shall be front removable and UL listed for 60ºC and 75ºC copper or aluminum cables. All switches blades and contacts shall be plated copper. Adjust fuse block to accept Class J fuses.

B. Switch Mechanism

1. 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. Padlocking provisions shall be provided for locking in the "OFF" position with at least three padlocks. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the "ON" position, and to prevent closing of the switch mechanism with the door open. A means shall be provided to permit authorized personnel to release the interlock for inspection purposes. Handle position shall indicate if switch is "ON" or "OFF".

C. Neutral

1. Provide a solid neutral with the safety switch where a neutral is present in the circuit.

D. Ratings

1. Switches shall be horsepower rated for ac and/or dc as indicated by the plans. The fused switches shall have Class R rejection fuse clips or adjusted for Class J fuses. UL listed short circuit ratings of the switches, when equipped with Class R fuses, shall be 200,000 symmetrical amperes.

E. Enclosures

1. Indoor switches shall be furnished in NEMA 1 enclosures.

2. Outdoor switches, switches located in wet areas or sprinkled areas shall be furnished in NEMA 3R enclosures.

3. Switches installed in wet areas such as cooling tower areas shall be NEMA 4X stainless steel or fiberglass reinforced polyester.

4. Switches installed in kitchens shall be stainless steel.

5. Switches installed in areas of a corrosive nature and subjected to salt air shall be NEMA 4X stainless steel or fiberglass reinforced polyester.

F. Electrical Interlock Contacts

1. Provide electrical interlock contacts on all disconnect switches serving motors in which remote VFDs are serving the motor. Provide conductors from contacts to the safe circuit inside the VFD. De-energizing the disconnect switch shall signal VFD to stop.

G. Service Entrance

1. Switch shall be suitable for use as service entrance equipment when installed in accordance with the National Electrical Code.

PART 3 - EXECUTION

3.1 GENERAL

A. Install safety and disconnect switches, including electrical connections, and fuses in accordance with manufacturer's written instructions, NEC and recognized industry practices.

B. Location: Install switches within sight of controllers.

C. Hubs: Provide bolt-on hubs for rainproof or wet area applications.

3.2 IDENTIFICATION

A. Nameplate: Each disconnect switch shall have an engraved bakelite nameplate. Nameplates shall be white with black letters and show equipment served. Nameplates shall be attached with stainless steel screws.

END OF SECTION

SECTION 26 29 01 - MOTORS AND STARTERS

PART 1 - GENERAL

1.1 SCOPE

A. Provide manual motor starters as shown, scheduled and as specified herein.

B. All integral motor starters furnished under Division 23 requirements shall be installed under Division 26 requirements unless noted otherwise on the plans.

1.2 STANDARDS

A. Products shall be designed, manufactured, tested and installed in compliance with applicable standards.

B. Products shall conform to all applicable UL standards and shall be UL-labeled.

1.3 ACCEPTABLE MANUFACTURERS

A. Provide one of the following manufacturers:

1. ABB/General Electric Company
2. Square D Company
3. Siemens
4. Eaton

1.4 SUBMITTALS

A. Shop drawings shall include, but not be limited to:

1. Cutsheets of all enclosures, switches, overloads, ratings, and all accessories clearly labeled.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. WORK IN ACCORDANCE WITH:

1. National Electrical Code.
2. Local, municipal, or state codes that have jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. GENERAL: Refer to the Drawings for starter requirements for each motor.

2.2 MANUAL MOTOR STARTERS

A. GENERAL: Manual starters shall consist of a manually operated toggle switch equipped with melting alloy type thermal overload relay. Thermal unit shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed. Contacts shall be double break, silver alloy, visible from both sides of starter. Manual starters shall be square "D" class 2510 or 2512 or approved equal. Provide the size and number of poles shall be as shown and required by equipment served. Furnish red pilot light as indicated.

B. ENCLOSURES: All manual motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise. Provide NEMA 3R enclosure where installed outside or in a sprinkled area.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTORS

A. GENERAL: Mount electric motors which are not factory installed.

B. MOTOR CONNECTIONS: Provide electrical and grounding connections to motors as indicated. Connections as follows:

1. Not less than 18 inch length of Sealtite, extending from motor connection box to motor branch circuit conduit on outdoor and wet locations. Provide Greenfield for inside dry locations.

2. Install connections mechanically secure, assuring electrical continuity, proper and effective grounding.

C. INSTALLATION OF MOTOR STARTER

1. Install motor starters in accordance with the manufacturer`s written instructions, the applicable requirements of the NEC and the NECA`s "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.

2. Combination starter disconnects and starters mounted in ceiling plenums shall be installed 18” above ceiling grid.

END OF SECTION