Project Manual

Balcones Heights Justice Center/City Hall HVAC Replacement

City of Balcones Heights, Texas

October 18, 2017
100% Construction Documents
Issued for Bidding

Prepared by
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END OF SECTION

SECTION 01 10 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 PROJECT IDENTIFICATION

HVAC Equipment Replacement

1.2 CONTRACT DESCRIPTION

A. This project is for the City of Balcones Heights City Hall. All of the HVAC equipment will be removed and replaced. The DDC control system will also be replaced. The equipment consists of 2 Air Handling Units (AHU) each have a remote air cooled condensing associated with it. These two units serve the first floor. There is a Roof Top Unit (RTU) which serves the second floor. There are 20 fan powered variable air volume boxes and 6 single terminal variable air volume boxes. The control system will be replaced with a new control system with web based interface. There will be a few temporary spot coolers (shown on the drawings) in the police dispatch and patrol office.

1. Project Location: 3300 Hillcrest Dr. Balcones Heights, TX 78201.

2. Project Manager: Mehdi Mirmomeni P.E. and Thomas Irwin have been appointed by the City of Balcones Heights to serve as the Project Manager and Assistant Project Manager.

1.3 WORK SEQUENCE

A. The work shall be conducted in the sequence as noted on the construction drawings. Most of the work shall be done after normal business hours Monday thru Friday 8am to 5pm and on weekends. All work requiring an electrical service outage shall be done on the weekends. Non disruptive work can be accomplished during business hours as long as it does not impact comfort or the operations of city staff, solely at the discretion of city officals.

1.4 WORK BY OWNER

A. Concurrent work by Owner or others: Owner reserves the right to conduct minor work with his own forces or separate contractors during the construction. Work will be coordinated with the contractor.

1.5 OWNER SUPPLIED PRODUCTS

A. Owner will arrange for and deliver Owner-furnished items.

B. Owner will arrange and pay for delivery of Owner-furnished items according to Contractor's Construction Schedule.

C. If Owner-furnished items are damaged, defective, or missing, Owner will arrange for replacement.

D. Owner will furnish Contractor the earliest possible delivery date for Owner-furnished products. Using Owner-furnished earliest possible delivery dates, Contractor shall designate delivery dates of Owner-furnished items in Contractor's Construction Schedule.

E. Contractor shall review Shop Drawings, Product Data, and Samples and return them to Architect noting discrepancies or anticipated problems in use of product.

F. If Owner-furnished items are damaged as a result of Contractor's operations, Contractor shall repair or replace them.

1.6 CONTRACTOR'S USE OF SITE AND PREMISES

A. Access to Site: Contractor will have restricted access to site. The City of Balcones Heights will require all construction workers to have identification badges. The City shall provide the badging. The City shall have the authority on whom and how all personnel will be allowed to access the building and premise. Contractor shall have use of a portion of the back parking lot for laydown and staging area. Contractor's use of premises is also limited by Owner's right to perform work or to retain other contractors on portions of other projects.

B. Parking: Contractor can use available parking spaces after 5:00 PM, before 8:00 AM Monday thru Friday, and on weekends. Contractor is encouraged to use carpooling with parking offsite at the nearby mall.

1.7 PORTABLE TOILETS

A. Contractors shall provide portable toilets (3- 4) for construction workers. Bathrooms in the building will be off limits to the construction staff.

1.8 SPECIFICATION CONVENTIONS

A. These specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words “shall be” are included by inference where a colon (:) is used within sentences or phrases. Except where specifically intended otherwise, the subject of all imperative statements is the Contractor. For example, 'Provide tile' means 'Contractor shall provide tile.

1.9 CONTRACTOR

A. Permits and Fees: Contractor shall be responsible to obtain and pay for all Permit and inspection fees.

B. All inspections at site will be conducted by City of Balcones Heights staff.

C. Codes: Comply with applicable codes and regulations of authorities having jurisdiction. Submit copies of inspection reports, notices and similar communications to Owner. Primary codes will be NEC-2014 and the 2009 IMC.

D. Dimensions: Verify dimensions indicated on drawings with field dimensions before fabrication or ordering of materials. Do not scale drawings.

E. Existing Conditions: Notify Owner of existing conditions differing from those indicated on the drawings. Do not remove or alter structural components without prior written approval of the project manager.

F. Coordination:
   1. Coordinate the work of all trades.
   2. Prepare coordination drawings for areas that receive new work. These drawings shall establish routing of electrical work so as not to interfere with other existing utilities and/or building elements and mechanical and electrical work.
   3. Verify location of utilities and existing conditions prior to beginning work.

G. Installation Requirements, General:
   1. Inspect substrates and report unsatisfactory conditions in writing.
   2. Do not proceed until unsatisfactory conditions have been corrected.
   3. Take field measurements prior to fabrication where practical. Form to required shapes and sizes with true edges, lines and angles. Provide inserts and templates as needed for work of all trades.
   4. Install materials in accordance with Manufacturer's instructions and approved submittals and installation instructions.
   5. Install materials in proper relation with adjacent construction and with proper appearance.
   6. Restore units damaged during installation. Replace units which cannot be restored at no additional expense to the Owner.
   7. Refer to additional installation requirements and tolerances specified under individual specification sections.

H. Definitions:
   1. Provide: Furnish and install, complete with all necessary accessories, ready for intended use. Pay for all related costs.
   2. Reviewed: Review of items submitted. Not a limitation or release for compliance with the Contract Documents or regulatory requirements. Refer to "Submittal Procedures" in Division 01.

I. Intent: Drawings and specifications are intended to provide the basis for proper completion of the work suitable for the intended use. Anything not expressly set forth but which is reasonable implied or necessary for proper performance of the project shall be included.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 10 20
DEFINITIONS AND STANDARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Summary

B. Definitions

C. Specification Format and Content Explanation

D. Drawing Symbols

E. Industry Standards

F. Governing Regulations / Authorities

G. Submittals

1.2 SUMMARY: This section specifies administrative requirements for compliance with governing regulations, codes and standards.

A. Requirements include obtaining permits, licenses, inspections, releases and similar documentation, as well as payments, statements and similar requirements associated with regulations, codes and standards.

1.3 DEFINITIONS

A. General: Definitions contained in this Article are not necessarily complete, but are general to the extent that they are not defined more explicitly elsewhere in the Contract documents.

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; not limitation on location is intended except as specifically noted.

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

D. Review: The term "reviewed" where used in conjunction with the Architect/Engineer's action on the Contractor's submittals, applications, and requests, is limited to the responsibilities and duties of the Architect/Engineer stated in Uniform General Conditions. Such review shall not release the Contractor from responsibility to fulfill Contract Document requirements, unless otherwise provided in the Contract Documents.

E. Regulation: The term "Regulations" includes laws, statutes, ordinances 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 they are 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 use".

I. Installer: An "Installer" is 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 construction they are engaged to perform.

J. The term "experienced," when used with the term "Installer" means having a minimum of 5 previous Projects similar in size and scope to this Project and familiar with the precautions required, and has complied with requirements of the authority having jurisdiction.

K. Project Site is the space available to the Contractor for performance of the Work, either exclusively or in conjunction with others performing other construction 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.

L. 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. TxDOT reserves the right and at its sole discretion to perform as the “test laboratory”, in part or in entirety, utilizing TxDOT laboratories and staff.

1.4 SPECIFICATION FORMAT AND CONTENT EXPLANATION: This Article is provided to help the user of these specifications understand the format, language, implied requirements, and similar conventions. None of the explanations shall be interpreted to modify the substance of Contract requirements.

A. Specification Format: These Specifications are organized in accordance with Construction Specifications Institute (CSI) 44 major division’s format. This organization conforms generally to recognized construction industry practice.

B. Specification Content: This Specification has been produced employing 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. 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 Language is used generally in the Specifications. Requirements expressed imperatively 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 Specifications 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 the 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 trades persons of the corresponding generic name.

1.5 DRAWING SYMBOLS

A. Graphic Symbols used on the Drawings are those recognized in the construction industry for purposes indicated. Where not otherwise noted, symbols are defined by "Architectural Graphic Standards," published by John Wiley & Sons, Inc., seventh edition.

B. Mechanical/Electrical Drawings: Graphic symbols used on mechanical and electrical Drawings are generally aligned with symbols recommended by ASHRAE. Where appropriate, they are supplemented by more specific symbols recommended by technical associations including, ASME, ASPE, IEEE and similar organizations. Refer instances of uncertainty to the Architect/Engineer for clarification before proceeding.

1.6 INDUSTRY STANDARDS

A. Applicability of Standards: Except where Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into 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.
   1. Referenced standards take precedence over standards that are not referenced but recognized in the construction industry as applicable.
   2. Non-referenced standards are not directly applicable to the Work, except as a general requirement of whether the Work complies with construction industry standards.
   3. Non-referenced standards: Except as otherwise limited by the Contract Documents, standards not referenced by recognized in the industry as applicable will be enforced for performance of the Work. The Architect/Engineer will decide whether a code or standard is applicable, or which of several are applicable.

B. Publication Dates: Where compliance with an industry standard is required, comply with standard in effect as of date of Contract Documents.
   1. Updated Standards: At the request of the Architect/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 Architect/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 Architect/Engineer for a decision before proceeding.
   1. Minimum Quantities 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 Architect/Engineer for 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 entities' 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.
   2. Although copies of standards needed for enforcement of requirements may be part of required submittals, the Architect/Engineer reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

F. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms 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 as of date of Contract Documents:

ACI	American Concrete Institute, P. O. Box 19150 Detroit, MI 48219	313-532-2600
ACIL	American Council of Independent Laboratories 1725 K Street, NW Washington, DC 20006	202-887-5872
ACPA	American Concrete Pipe Association 8320 Old Courthouse Road Vienna, VA 22180	703-821-1990
AGA	American Gas Association 1515 Wilson Blvd. Arlington, VA 22209	703-841-8400

AIA	American Institute of Architects 1735 New York Ave., NW Washington, DC 20006	202-626-7300
AIHA	American Industrial Hygiene Association 475 Wolf Ledges Parkway Akron, OH 44311	216-762-7294
AISC	American Institute of Steel Construction 400 No. Michigan Ave., 8th Floor Chicago, IL 60611	312-670-2400
AISI	American Iron and Steel Institute 1000 Sixteenth St., N.W. Washington, DC 20036	202-452-7100
ALI	Associated Laboratories 641 So. Vermont Street Palatine, IL 60067	312-358-7400
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018	212-354-3300
API	American Petroleum Institute 1220 L Street, N.W. Washington, DC 20005	202-682-8000
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, New York 10017	212-705-7722
ASPE	American Society of Plumbing Engineers 3617 Thousand Oaks Blvd., Suite 210 Westlake, CA 91362	805-495-7120
ASSE	American Society of Sanitary Engineering P. O. Box 40362 Bay Village, OH 44140	216-835-3040
ASTM	ASTM 1916 Race St. Philadelphia, PA 19103	215-599-5400
AWS	American Welding Society P. O. Box 351040 550 Le Jeune Road, NW Miami, FL 33135	305-443-9353
AWWA	American Water Works Association 6666 W. Quincy Ave. Denver, CO 80235	303-794-7711
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Road Schaumburg, IL 60195	312-490-1700

IEEE	Institute of Electrical and Electronic Engineers 345 E. 47th St. New York, NY 10017	607-723-3531
ISA	Instrument Society of America P. O. Box 12277 67 Alexander Drive Research Triangle Park, NC 27709	919-549-8411
LPI	Lightning Protection Institute P. O. Box 458 Harvard, IL 60033	815-943-7211
MCAA	Mechanical Contractor's Association of America 5410 Grosvenor Lane, Suite 120 Bethesda, MD 20814	301-897-0770
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry 127 Park St., NE Vienna, VA 22180	703-281-6613
NAPA	National Asphalt Pavement Association Calvert Building, Suite 620 6811 Kenilworthy Ave. Riverdale, MD 20737	301-779-4880
NEC	National Electric Code (by NFPA)	
NECA	National Electrical Contractors Association 7315 Wisconsin Ave. Bethesda, MD 20814	301-657-3110
NEMA	National Electrical Manufacturers Association 2101 L Street, NW, Suite 300 Washington, DC 20037	202-457-8400
NFPA	National Fire Protection Association Batterymarch Park Quincy, MA 02269	617-770-3000
NPCA	National Paint and Coatings Association 1500 Rhode Island Ave., NW Washington, DC 20005	202-462-6272
PDI	Plumbing and Draining Institute (c/o Austin O. Roche, Jr.) 5342 Boulevard Pl. Indianapolis, IN 46208	317-251-5298
PEI	Petroleum Equipment Institute 6514 East 69th St. Tulsa, OK 74133-1719	918-494-9696
SSPC	Steel Structures Painting Council 4400 Fifth Avenue Pittsburgh, PA 15213	412-578-3327
UL	Underwriters Laboratories	312-272-8800

	333 Pfingsten Rd. Northbrook, IL 60062	
WRI	Wire Reinforcement Institute 8361 A Greensboro Drive McLean, VA 22102	703-790-9790
WSC	Water Systems Council 600 S. Federal St., Suite 400 Chicago, IL 60605	312-922-6222
WWPA	Woven Wire Products Association 2515 No. Nordica Ave. Chicago, IL 6063	312-637-1359

1.7 GOVERNING REGULATIONS/AUTHORITIES: The Architect/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.

A. Copies of Correspondence: During preparation of the Contract Documents, the Architect/Engineer has maintained a file containing correspondence with authorities having jurisdiction. This file is available at the Architect/Engineer's office for reference. If requested, the Architect/Engineer will provide copies of correspondence at cost of reproduction.

B. Copies of Regulations: Obtain copies of the following regulations and retain at the Project Site, available for reference by parties who have a reasonable need for such reference.

C. Trade Union Jurisdictions: The Contractor shall maintain, and require subcontractors to maintain complete current information on jurisdictional matters, regulations and pending actions, as applicable to construction activities. The manner in which Contract Documents have been organized and subdivided is not intended to indicate of trade union or jurisdictional agreements.
   1. Discuss new developments at Project meetings at the earliest feasible dates. Record relevant information and actions agreed upon.
   2. Assign and subcontract construction activities, and employ tradesmen and laborers, in a manner that will not unduly risk jurisdictional disputes that could result in conflicts, delays, claims and losses.

1.8 SUBMITTALS

A. 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 Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 10 30
SPECIFICATION OUTLINE

PART 1 GENERAL

1.1 SECTION INCLUES

A. Summary

B. Specification Format

C. Clarifications

1.2 SUMMARY

A. The purpose of this section is to describe the organization and format to which the Specification has been prepared. This section is intended as an aid to the comprehension of the specification.

1.3 SPECIFICATION FORMAT

A. The Specification has been prepared in accordance with Construction Specifications Institute (CSI) Format.

B. The CSI format is subdivided into 44 major divisions. Divisions form the framework of this Specification and contain the technical requirements for the category of work within each division. Divisions that are not applicable to this specification are not used.

C. Sections within each division describe the specific requirements for different units of work based on trade or type of work. Sections within divisions are arranged in numerical order; however, section numbers may be assigned differently in separate divisions. Page numbering is subordinate to section numbering.

D. Sections are sub-divided into three distinct groupings of related information as follows:
   1. Part 1 - General: Defines the administrative and procedural requirements unique to the section.
   2. Part 2 - Products: Details the quality and features of items required for the project.
   3. Part 3 - Execution: Details the incorporation of the products into the project.
      Most sections contain all three sub-divisions; however, they are included only where needed. Paragraph designations are subordinate to sub-divisions.

E. Many sections do not stand alone and are related to other portions of the Subcontract documents. Some sections are specific extensions of, or are governed by the general requirements of Division 1. Requirements of the Subcontract Documents shall apply as a whole, regardless of any overlapping of various portions of the specification.

F. This specification has been written in the imperative mood and, in some cases, in a streamlined form. The imperative language is directed to the Contractor, unless specifically noted otherwise.

PART 2 CLARIFICATIONS

A. Most sections begin with a paragraph in Part 1 entitled "Summary" or "Scope of Work". These paragraphs provide a brief description of the work specified in that Section. These descriptions are not intended to be all-inclusive, but provide a brief clarification of the particular subject matter in the specification.

B. Some technical sections contain a paragraph entitled "Related Sections" or "Related Work Specified Elsewhere". This paragraph lists some of the related work specified in other sections of the Subcontract Documents. These listings are not intended to be all-inclusive. They are presented as a means of aiding the Subcontractor in locating other specification sections containing work that has a close relationship with the work specified in that section. The requirements of the Subcontract Documents, including all specifications, shall apply as a whole.

C. Reference standards are incorporated into the specifications by reference number, title or other designations. The provisions of these standards become a part of the specification as though included in their entirety. When there is a conflict or discrepancy between a reference standard and the specification or with another reference standard, the more stringent requirements shall apply.

D. In the event of a Discrepancy between a drawing and the specification refer to General Conditions Article 6.

E. No typographical or other error on drawings shall relieve the Sub-Contractor from his responsibility to perform the intent of this Subcontract.

PART 3 PRODUCTS - Not Used

PART 4 EXECUTION - Not Used

END OF SECTION

SECTION 01 20 00
PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Schedule of values.

B. Applications for payment.

C. Change procedures.

D. Defect assessment.

1.2 SCHEDULE OF VALUES

A. Submit printed schedule on Owner provide form or electronic media.

B. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
   1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets
      b. Submittals Schedule
      c. Contractor's Construction Schedule
   2. Submit the Schedule of Values to the Engineer in duplicate no later than seven days before the date scheduled for submittal of initial Applications for Payment.

C. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section. Identify separately site mobilization, bonds and insurance, and a breakdown of the General Contractors general conditions.
   1. Identification: Include the following Project identification on the Schedule of Values:
      a. Project name and location
      b. Name of Engineer
      c. City of Balcones Heights project number
      d. Contractor's name and address
      e. Date of submittal
   2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
      a. Related Specification Section or Division
      b. Description of the Work
      c. Change Orders (numbers) that affect value
      d. Allowances (numbers) per bid proposal
      e. Dollar value
         1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent

3. Provide a breakdown of the Contract Sum (labor & materials) in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
    a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing.
6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Provide separate line items in the Schedule of Values for each Allowance per bid proposal.
8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.
10. Provide any additional information as set forth in the UGC.

1.3 APPLICATIONS FOR PAYMENT

A. Submit two copies of each application to Engineer for review, 7 days prior to Payment Application Time.

B. Each monthly Application for Payment shall be consistent with previous applications and payments as certified by Engineer, and the City of Balcones Heights (City) Project Manager.
    1. Initial Application for Payment, Application for Payment at Substantial Completion, and final Application for Payment require additional documentation.

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

D. Payment Application Forms: Use the standard AIA payment application forms.

E. Application Preparation: Complete every entry on form. Engineer and City, and the City Project Manager will return incomplete applications without action.
    1. Entries shall match data on the Schedule of Values. Use updated schedule if revisions were made.
    2. Include amounts of Change Orders approved before last day of construction period covered by application.

3. Submit Contractor's Affidavit of Payment of Debts and Claims – Monthly Progress Payment
4. Submit HUB Subcontracting Plan (HSP) Prime Contractor Progress Assessment Report.
5. Submit updated two construction schedules with each Application for Payment.

F. Transmittal: Submit 5 signed original copies of each Application for Payment to Engineer by a method ensuring receipt within 24 hours.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
   1. List of subcontractors
   2. Schedule of Values
   3. Contractor's Construction Schedule
   4. Products list
   5. Schedule of unit prices
   6. Submittals Schedule
   7. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work

H. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment for portion of the Work claimed as substantially complete.
   1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
   2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

I. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
   1. Updated final statement, accounting for final changes to the Contract Sum
   2. Owner provided document , "Contractor's Affidavit of Payment of Debts and Claims –Final Payment"
   3. Owner provided document, "Consent of Surety to Final Payment"
   4. Evidence that claims have been settled
   5. Final liquidated damages settlement statement if applicable.
   6. HUB Subcontracting Plan (HSP) Prime Contractor Progress Assessment Report.
   7. Buy America form D-9-USA 1 or it equivalent.
   8. If required, a close-out Change Order.
   9. Provide any additional information as set forth in UGC.

J. Substantiating Data: When Engineer requires substantiating information, submit data justifying dollar amounts in question. Include the following with Application for Payment:

   1. Affidavits attesting to off-site stored products.
   2. Construction progress schedules, revised and current.

1.4 CHANGE PROCEDURES

A. Submittals: Submit name of individual authorized to receive change documents, and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.

B. The Engineer will advise of minor changes in the Work not involving adjustment to Contract Sum/Price or Contract Time by issuing supplemental instructions.

C. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Proposal Requests issued by Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
   2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

D. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Engineer.
   1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
   2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   3. Indicate applicable delivery charges, equipment rental, and amounts of trade discounts.
   4. Include costs of labor and supervision directly attributable to the change.
   5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
   6. Use City approved Proposal Requests.
      a. Document each quotation for change in cost or time with sufficient data to allow evaluation of quotation.

1.5 CHANGE ORDER PROCEDURES

A. On approval of a Proposal Request, Owner will issue a Change Order for signatures of Contractor and Engineer on Owner's appropriate form.
   1. Execution of Change Orders: Owner will issue Change Orders for signatures of parties as provided in the Contract Document. Final approval of a Change Order is reserved solely to the City in accordance with City signature authorization policy and may not be delegated.

B. Correlation Of Contractor Submittals:
   1. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as separate line item and adjust Contract Sum/Price.
   2. Promptly revise progress schedules to reflect change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
   3. Promptly enter changes in Project Record Documents.

1.6 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to specified requirements.

B. If, in the opinion of the Engineer, it is not practical to remove and replace the Work, the Engineer and/or Owner will direct appropriate remedy or adjust payment.

C. The defective Work may remain, but unit sum/price will be adjusted to new sum/price at discretion of Engineer and/or Owner.

D. Defective Work will be partially repaired to instructions of Engineer and/or Owner and unit sum/price will be adjusted to new sum/price at discretion of Engineer and /or Owner.

E. Individual specification sections may modify these options or may identify specific formula or percentage sum/price reduction.

F. Authority of Engineer and/or Owner to assess defects and identify payment adjustment, is final.

G. Non-Payment For Rejected Products: Payment will not be made for rejected products for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.
   2. Products determined as unacceptable before or after placement.
   3. Products not completely unloaded from transporting vehicle.
   4. Products placed beyond lines and levels of required Work.
   5. Products remaining on hand after completion of the Work.
   6. Loading, hauling, and disposing of rejected products.
   7.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION

SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Product list

B. Contractor’s Options

C. Substitutions

D. Quality assurance.

E. Product options.

F. Substitution Request Forms

1.2 PRODUCT LIST

A. Within 30 days after date of Contract, submit to Architect/Engineer five (5) copies of complete list of products and materials which are proposed for installation.

B. Prepare list on basis of each Specification section.

C. For products specified under reference standards, include with listing of each product:
   1. Name and address of manufacturer.
   2. Trade name.
   3. Model or catalog designation.
   4. Manufacturer's data, including performance and test data, reference standards.

1.3 CONTRACTOR'S OPTIONS

A. For products specified only by reference standards, select any product meeting standards, by any manufacturer.

B. For products specified by naming several products or manufacturers, select any product and manufacturer named.

C. For products specified by naming only one product and manufacturer, there is no option, unless a substitution is approved as specified below.

1.4 SUBSTITUTIONS

A. During Bidding: Architect/Engineer will consider written requests from prime Bidders for substitutions, received by the Architect/Engineer 14 days prior to bid date. Requests received by the Architect/Engineer after 14 days before bid date will not be considered. Approval of proposed substitutions will be set forth in an Addendum. Requests for substitutions shall be in accordance with the provisions set forth in this Section. Approval of a proposed substitution

does not relieve the Contractor from compliance with the requirements of the plans and specifications for the item(s). Receipt by the Owner of a substitution request does not constitute receipt by the Architect/Engineer.

B. After Bidding: Within seven (7) days after date of Contract, Architect/Engineer will consider formal requests from Contractor for substitutions of products in place of those specified. No request for substitutions will be considered after this date. Approval of a proposed substitution does not relieve the Contractor from compliance with the requirements of the plans and specifications for the item(s).

C. Submit two (2) copies of Substitution Request Form. Include in substitution request:
   1. Data substantiating compliance of proposed substitution with Contract documents.
   2. For products:
      a. Product identification, including manufacturer's name and address.
      b. Manufacturer's literature, including product description, performance and test data and reference standards.
      c. Samples, if applicable.
      d. Name and address of similar projects on which product was used and date of installation.
   3. For construction methods:
      a. Detailed written descriptions of proposed method.
      b. Complete drawings illustrating methods or revisions.
   4. Itemized comparison of proposed substitution with product or method specified.
   5. Data relating to changes in construction schedule.

D. In making request for substitution, Bidder/Contractor represents:
   1. He has personally investigated proposed product or method and determined that it is equal or superior in all respects to that specified.
   2. He will provide same guarantee for substitution as for product or method specified.
   3. He will coordinate installation of accepted substitution into work, making such changes as may be required for work to be complete in all respects.
   4. He waives all claims for additional costs related to substitution which subsequently becomes apparent

E. Conditions: Architect/Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer will return requests without action, except to record noncompliance with these requirements.
   1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect/Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
   2. Requested substitution does not require extensive revisions to the Contract Documents.
   3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
   4. Substitution request is fully documented and properly submitted.
   5. Requested substitution will not adversely affect Contractor's Construction Schedule.
   6. Requested substitution has received necessary approvals of authorities having jurisdiction.
   7. Requested substitution is compatible with other portions of the Work.

8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.

F. Substitutions will not be considered if:
1. They are indicated or implied on show drawings or product data submittals without formal request as submitted in accordance with the provisions of this Section.
2. Acceptance will require substantial revision of Contract Documents.

1.5 QUALITY ASSURANCE

A. Contract is based on products and standards established in Contract Documents without consideration of proposed substitutions.

B. Products specified define standard of quality, type, function, dimension, appearance, and performance required.

C. Substitution Proposals: Permitted for specified products except where specified otherwise. Do not substitute products unless substitution has been accepted and approved in writing by Owner.

1.6 PRODUCT OPTIONS

A. See Section 01 60 00 - Product Requirements.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

COMPLETE SECTIONS 1 THROUGH 7, SIGN AND DATE.

SUBSTITUTION REQUEST
PROJECT: _____ PROJECT NO. : _____

TO: David Harris
City Administrator
City of Balcones Heights
3300 Hillcrest Dr.
Balcones Heights, TX 78201

FROM (CONTRACTOR/BIDDER):
_____
_____

CONTRACTOR (BIDDER) HEREBY REQUESTS ACCEPTANCE OF THE FOLLOWING PRODUCT OR SYSTEMS AS A SUBSTITUTION IN ACCORD WITH THE PLANS AND SPECIFICATONS AND TERMS AND CONDITONS OF THE CONTRACT DOCUMENTS.

1. SPECIFIED PRODUCT OR SYSTEM:
   Substitution request for (Generic Description): _____

   Specification Section No.: _____ Article(s) _____ Paragraph(s) _____

2. SUPPORTING DATA:
   Product data for proposed substitution is attached (description of product, reference standards, performance and test data).

   Sample is attached _____ Sample will be sent if requested _____

3. QUALITY COMPARISON:

	SPECIFIED PRODUCT	SUBSTITUTION
Name brand:	_____	_____
Catalog No.	_____	_____
Manufacturer:	_____	_____
Vendor:	_____	_____
Significant Variations:	_____	_____
	_____	_____

Maintenance Service Available: _____ Yes _____ No

Spare Part Source: _____

4. PREVIOUS INSTALLATIONS:
   Identification of similar projects on which proposed substitution was used:

   Project: _____ Architect/Engineer: _____

   Address: _____ Owner:_____

   _____ Date Installed: _____

   _____

5. REASON FOR NOT GIVING PRIORITY TO SPECIFIED ITEMS:

   _____

   _____

6. EFFECT OF SUBSTITUTION:
   Proposed substitution affects other parts of Work: [No] _____ [Yes] _____ (If yes, explain)

   _____

   _____

   _____

   Change Contract Time: [No] _____ [Yes] _____ (If yes) Add _____ days, Deduct _____ days.

   Substitution requires dimensional revision or redesign of structure or M & E Work:

   [No] _____ [Yes] _____ (If yes, attach compete data).

   Saving or credit to Owner, if any, for accepting substitution: $ _____

   Extra cost to Owner, if any, for accepting substitution: $ _____

7. CONTRACTOR'S (BIDDER'S) STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENTS.

I/we have investigated the proposed substitution.
I/we:
___ believe that it is equal or superior in all respects to specified product, except as stated above.
___ will provide the same warranty as specified for specified product.
___ have included complete cost data and implications of the substitution.
___ will pay redesign and special inspection costs caused by the use of this product.
___ will pay all direct and indirect additional costs to other contractors caused by the substitution.
___ will coordinate the incorporation of the proposed substitution in the Work.
___ will modify other parts of the work as may be needed, to make all parts of the work complete and functioning.
___ waive future claims for added cost to Contract caused by the substitution.

Contractor (Bidder): _____ Date: _____

By: _____

Answer all questions and complete all blanks - use "N/A" if not applicable.

ARCHITECT/ENGINEER REVIEW AND ACTION

___ Resubmit substitution request:

___ Provide more information in following categories.

_____

___ Sign Contractor's (Bidder's) Statement of Conformance.

___ Substitution accepted.

___ Substitution is accepted with the following comments.

_____

_____

___ Substitution not accepted.

____Substitution Request received too late.

_____ _____
Engineer of Record Date

END OF SECTION

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. 01 32 10 Construction Progress Schedule

1.2 SECTION INCLUDES

A. Coordination and project conditions

B. Construction Layout

C. Field engineering

D. Preconstruction meeting

E. Monthly Progress meetings

F. Pre-installation meetings

G. Coordination meetings

1.3 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

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

1. Provide project superintendent and other supervisory personnel required for proper performance of the work.
2. Submit list of sub-contractors names, phone numbers and trade work.
3. Participate in a pre-construction meeting at a time and place determined by the Owner for the purpose of identifying responsibilities of the Owner’s and Engineer’s personnel and explanation of administrative procedures.
4. Schedule and conduct monthly meetings, distribute meeting Minutes.
5. Schedule and conduct other meetings as necessary, distribute meeting Minutes.
6. Owner to schedule and conduct other meetings as necessary, the Owner will distribute meeting Minutes.
7. Preparation of Contractor's Construction Schedule.
8. Preparation of the Schedule of Values.
9. Installation and removal of temporary facilities and controls.
10. Preparation of the Submittal Review Schedule.
11. Delivery and processing of submittals.

12. Progress meetings.
13. Preinstallation conferences.
14. Project closeout activities.
15. Startup and adjustment of systems.
16. Project closeout activities.
17. Submit bar chart progress schedule, updated monthly.
18. Prepare submittal schedule coordinated with progress schedule.
19. Submit schedule of values, divided so as to facilitate payments to subcontractors, on forms acceptable to the Owner. Schedule, when approved, will be used as the basis for the Contractor's Application for payment.
20. Submit schedule of required tests.
21. Perform all field engineering, layout, and surveying required for layout of project.
22. Submit and post a list of emergency telephone numbers and addresses for individuals to be contacted in case of emergency.
23. Record drawings and specifications to be maintained and annotated by contractor as work progresses to record actual construction, and be turned over to the Engineer at substantial completion. See Section 01 70 00 and Uniform General Conditions for additional information.
24. Submit payment request procedures.
25. Perform quality control during installation.
26. Clean and protect the work.

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

D. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

E. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.

G. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion and for portions of Work designated for Owner's partial occupancy.

H. After Owner occupies the premises any access to complete remaining Work or correct defective Work must be coordinated with the Owner's representative in order to minimize disruption of Owner's activities.

1.4 CONSTRUCTION LAYOUT

A. The General Contractor shall include in his bid the cost for providing all construction staking by a Registered Public Surveyor (Surveyor) licensed by Texas Board of Professional Land Surveyors who can demonstrate experience and competence to perform the work described. The grades, spot elevations, dimensions radii, flow line elevations, existing bench marks, excavation and site grading will be indicated on the plans. In the event that discrepancies are noted in the plans by the Contractor and/or the Surveyor, the Engineer of Record shall be notified and the discrepancies shall be resolved prior to proceeding with the Work. The Surveyor shall supervise the layout work and establish at least three (3) separate permanent bench marks, to which easy access may be had during the progress of the work, to determine and verify lines and grades.

B. Under the supervision of the Surveyor, the layout of the work shall be made from the surveyor-established base lines, utility alignments, curb faces, key trees, bench marks and all other control lines as indicated on the plans; and the Contractor shall be responsible for all measurements in connection therewith as specified and as indicated on the plans.

C. Contractor shall be responsible for having the Surveyor verify that elevations of form work. The Surveyor shall return a second time to verify site grading, sidewalk elevations, rough grading next to buildings, concrete curb elevations, base material elevations prior to paving. All surveying work shall comply with the elevations, lines and grades shown on the plans and provide a written report and large size (22” x 34”) drawings indicating findings to the Engineer of Record for consideration and response prior to placing concrete, placing asphalt or install landscaping. Contractor shall not proceed further without Surveyor’s Report / Drawings and the contractor shall be responsible for making the required corrections prior to continuing the Work. No extra charge or compensations will be allowed due to differences between actual dimensions and the measurements indicated on the drawings.

D. Employ Land Surveyor registered and acceptable to the Owner.

E. Locate and protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.

F. Control datum for survey is that established by Owner provided survey.

G. Verify set-backs and easements; confirm drawing dimensions and elevations.

H. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

I. Submit copy of site drawing signed by Land Surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

J. Maintain complete and accurate log of control and survey work as Work progresses.

K. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

L. Promptly report to Engineer loss or destruction of reference point or relocation required because of changes in grades or other reasons.

M. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

1.5 PRECONSTRUCTION MEETING

A. The Owner's Representative will schedule a pre-construction conference and organizational meeting at the Project Site or other convenient location after execution of the Agreement and prior to commencement of construction activities. The Owner's Representative will conduct the meeting to review responsibilities and personnel assignments.

B. Attendees shall include: The Owner, Engineer and their consultants, the Contractor and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the Work.

C. The Agenda shall: Discuss items of significance that could affect progress including such topics as:
1. Tentative construction schedule
2. Critical Work sequencing
3. Designation of responsible personnel
4. List of Subcontractors, trade work, names and phone numbers
5. Procedures for processing field decisions and Change Orders
6. Procedures for processing Applications for Payment
7. Distribution of Contract Documents
8. Submittal of Shop Drawings, Product Data and Samples
9. Preparation of record documents
10. Use of the premises
11. Office, Work and storage areas
12. Equipment deliveries and priorities
13. Safety procedures
14. First Aid
15. Security
16. Housekeeping
17. Working hours

D. The Owner's Representative will record Minutes and distribute copies within five days after meeting to participants, with copies to contractor and those affected by decisions made.
1. General Contractor will distribute Minutes to others.

1.6 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum bi-weekly intervals.
1. Coordinate dates of meetings with the Engineer.
2. Prepare Contractor's Application for Payment (CAP) on AIA standard payment application forms. Engineer shall provide forms required for payment submittal.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required: Job superintendent, major subcontractors and suppliers, Owner, Engineer, as appropriate to agenda topics for each meeting.

D. Agenda:
1. Review of Minutes of previous meetings
2. Review of Work progress
3. Field observations, problems, and decisions
4. Identification of problems impeding planned progress
5. Review of submittals schedule and status of submittals
6. Review of off-site fabrication and delivery schedules
7. Maintenance of progress schedule
8. Corrective measures to regain projected schedules
9. Planned progress during succeeding work period
10. Coordination of projected progress
11. Maintenance of quality and work standards
12. Effect of proposed changes on progress schedule and coordination
13. Other business relating to Work

E. Record Minutes and distribute copies within three days after meeting to participants, with copies to Engineer, Owner, and those affected by decisions made.

1.7 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections, convene pre-installation meetings at Project site prior to commencing work of specific section.

B. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify Engineer and Owner 14 days in advance of meeting date.

D. Prepare agenda and preside at meeting:
1. Review conditions of installation, preparation and installation procedures.
2. Review coordination with related work.
   a. Contract documents
   b. Options
   c. Related Change Orders
   d. Purchases
   e. Deliveries
   f. Shop Drawings, Product Data and Quality Control Samples
   g. Possible Conflicts
   h. Compatibility Problems
   i. Time Schedules
   j. Weather Limitations
   k. Manufacturer's Recommendations
   l. Compatibility of Materials
   m. Acceptability of Substrates
   n. Temporary Facilities

o. Space and Access Limitations
p. Governing Regulations
q. Safety
r. Inspection and Testing Requirements
s. Recording Requirements
t. Protection

E. Record Minutes and distribute copies within three days after meeting to participants, with copies to Engineer, Owner, and those affected by decisions made.
1. Do not proceed if the conference cannot be successfully concluded.
2. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.8 COORDINATION MEETINGS

A. Conduct project coordination meetings at regularly scheduled times convenient for all parties involved. Project Coordination meetings are in addition to specific meetings held for other purposes, such as regular progress meetings and specific pre-installation conferences.

B. Request representation at each meeting by every party currently involved in coordination or planning for the construction activities involved.

C. Record meeting decisions or action and distribute copies to everyone in attendance and to others affected by those decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Contractor's Construction Schedule
   2. Submittals Schedule
   3. Daily construction reports
   4. Field condition reports
   5. Special reports

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

1.3 SUBMITTALS

A. Submittals Schedule: Submit four copies of schedule and electronic file in MS Office Project. Arrange the following information in a tabular format:
   1. Scheduled date for first submittal
   2. Specification Section number and title
   3. Submittal category (action or informational)
   4. Name of subcontractor
   5. Description of the Work covered
   6. Scheduled date for Engineer's final release or approval

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

C. CPM Reports: Concurrent with CPM schedule, submit four copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
   1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.

2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

D. Daily Construction Reports: Submit two copies at monthly intervals, when requested.

E. Field Condition Reports: Submit two copies at time of discovery of differing conditions.

F. Special Reports: Submit two copies at time of unusual event.

1.4 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. If a Preliminary Construction Schedule is not required, delete subparagraph below or revise to require initial submittal within 14 days of date established for commencement of the Work.
3. Delete subparagraph below if not allowed.
4. Revise subparagraph below if schedule must be continuously updated to reflect current status and changes in timing for submittals.
5. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Engineer.
   2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
   3. Submittal Review Time: Include review and resubmittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
   4. Startup and Testing Time: Include not less than seven days for startup and testing.
   5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's and City of Balcones Heights Project Manager administrative procedures necessary for certification of Substantial Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
   1. Phasing: Arrange list of activities on schedule by phase.
   2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 1 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   4. Work Restrictions: Show the effect of the following items on the schedule:
      a. Seasonal variations
      b. Environmental control
   5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
      a. Submittals
      b. Mockups
      c. Fabrication
      d. Sample testing
      e. Deliveries
      f. Installation
      g. Tests and inspections
      h. Adjusting
      i. Curing
      j. Startup and placement into final use and operation
   6. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

a. Structural completion
b. Permanent space enclosure
c. Completion of mechanical installation
d. Completion of electrical installation
e. Substantial Completion

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
First paragraph below establishes progress measured in dollar volume of the Work.

F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
1. Refer to Division 1 Section "Payment Procedures" for cost reporting and payment procedures.
2. Retain three subparagraphs below for CPM schedule.
3. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Engineer's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
4. Each activity cost shall reflect an accurate value subject to approval by Engineer.
5. Total cost assigned to activities shall equal the total Contract Sum.

G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Projects using CPM schedules should begin with a preliminary network diagram of type described below or a preliminary bar-chart schedule.

C. Preliminary Network Diagram: Submit diagram within 14 days of date established for the Notice to Proceed. Outline significant construction activities for the first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

D. Revise paragraph and subparagraphs below to suit Project.

E. CPM Schedule: Prepare Contractor's Construction Schedule using a computerized, time-scaled CPM network analysis diagram for the Work.
1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 14 days after date established for the Notice to Proceed.

a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Engineer's approval of the schedule.

2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
3. Use "one workday" as the unit of time. Include list of nonworking days and holidays incorporated into the schedule.

F. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
   a. Preparation and processing of submittals
   b. Mobilization and demobilization
   c. Purchase of materials
   d. Delivery
   e. Fabrication
   f. Installation
   g. Testing
2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
   a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

G. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity
2. Description of activity
3. Principal events of activity
4. Immediate preceding and succeeding activities
5. Early and late start dates
6. Early and late finish dates
7. Activity duration in workdays
8. Total float or slack time
9. Average size of workforce
10. Dollar value of activity (coordinated with the Schedule of Values)

H. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed
2. Changes in early and late start dates
3. Changes in early and late finish dates
4. Changes in activity durations in workdays
5. Changes in the critical path
6. Changes in total float or slack time
7. Changes in the Contract Time

2.4 REPORTS

A. Daily Construction Reports: Maintain a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site
2. Approximate count of personnel at Project site
3. Material deliveries
4. High and low temperatures and general weather conditions
5. Accidents
6. Meetings and significant decisions
7. Unusual events (refer to special reports)
8. Stoppages, delays, shortages, and losses
9. Emergency procedures
10. Orders and requests of authorities having jurisdiction
11. Change Orders received and implemented
12. Proposed Construction Change Directives
13. Construction Change Directives received and implemented
14. Services connected and disconnected
15. Equipment or system tests and startups
16. Substantial Completions authorized

B. Field Condition Reports: Have field reports available for review by owner.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate Actual Completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.

2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

C. Distribution: Provide electronic copy to Engineer in MS Office Project format.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures

B. Construction progress schedules

C. Proposed products list

D. Subcontractor List

E. Product data

F. Shop drawings

G. Samples

H. Design data

I. Test reports

J. Certificates

K. Manufacturer's instructions

L. Manufacturer's field reports

M. Erection drawings

N. Construction photographs

O. Project Warranty And Maintenance Manual

1.2 SUBMITTAL PROCEDURES

A. General: Electronic copies of CAD Drawings of the Contract Drawings will not be provided by Engineer for Contractor's use in preparing submittals.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 21 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Engineer and to Engineer's consultants, allow 21 days for review of each submittal. Submittal will be returned to Engineer before being returned to Contractor.
5. Schedule submissions at least 40 days before reviewed submittals will be needed, in accordance with the above review times noted above (the above allows for one resubmittal review and distribution) and approved submittal schedule.

D. Insert list of submittals below allowing concurrent review or delete and identify submittals in Sections where they are specified. Structural, mechanical, plumbing, and electrical components are examples of the Work that often require simultaneous transmittal to Engineer and consultants.

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

1. Coordinate each submittal with requirements of work of Contract Documents.
2. Contractor’s responsibility for errors and omissions in submittals is not relieved by Engineer’s review of submittals.
3. Contractor’s responsibility for deviations in submittals from requirements of Contract Documents is not relieved by Engineer’s review of submittals, unless Engineer gives written acceptance of specific deviations.
4. Notify Engineer, in writing at time of submission, of deviations in submittals from requirements of Contract Documents.

F. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
3. Include the following information on label for processing and recording action taken:
   a. Project name
   b. Date
   c. Name and address of Engineer
   d. Name and address of Contractor
   e. Name and address of Subcontractor
   f. Name and address of Supplier
   g. Name of Manufacturer

h. Submittal number
i. Number and title of appropriate Specification Section
j. Drawing number and detail references, as appropriate
k. Location(s) where product is to be installed, as appropriate
l. Other necessary identification

G. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.

H. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.

I. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return submittals, without review, received from sources other than Contractor.
1. Transmittal Form: Use form acceptable to the Owner and Engineer. Provide locations on form for the following information:
a. Project name
b. Date
c. Destination (To)
d. Source (from)
e. Names of Subcontractor, Manufacturer, and Supplier
f. Category and type of submittal
g. Submittal purpose and description
h. Specification Section number and title
i. Drawing number and detail references
j. Transmittal number, numbered consecutively
k. Submittal and transmittal distribution record
l. Remarks
m. Signature of Transmitter

2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same label information as related submittal.

J. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. When revised for resubmission, identify changes made since previous submission.
2. Mark revised submittals with original number and sequential alphabetic suffix. Note date and content of previous submittal.
3. Note date and content of revision in label or title block and clearly indicate extent of revision.

K. Allow space on submittals for Contractor and Engineer/Engineer review stamps.

L. Resubmit submittals until they are marked 'REVIEWED'.

M. Distribution: Furnish copies of final submittals to Manufacturers, Subcontractors, Suppliers, Fabricators, Installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
   1. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

N. Use for Construction: Use only final submittals with mark indicating 'REVIEWED'.
   1. Begin no work which requires submittals until return of submittals with Engineer's stamp and initials or signature indicating review.

O. Submittals not requested will not be recognized or processed.

1.3 CONSTRUCTION PROGRESS SCHEDULES

A. Submit preliminary outline Schedules within 15 days after date of Owner-Contractor Agreement for coordination with Owner's requirements. After review, submit detailed schedules within 7 days modified to accommodate revisions recommended by Engineer/Engineer and Owner.

B. Related Section 01 32 16 – Construction Progress Schedule: Submit revised Progress Schedules with each Application for Payment.

C. Distribute copies of reviewed schedules to Project site file, Subcontractors, Suppliers, and other concerned parties.

D. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

E. Submit computer generated horizontal bar chart or other approved form with separate line for each section of Work, identifying first work day of each week.

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

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

H. Submit separate schedule of submittal dates for shop drawings, product data, and samples, including Owner furnished products and products identified under Allowances, and dates reviewed submittals will be required from Engineer/Engineer. Indicate decision dates for selection of finishes.

I. Indicate delivery dates for Owner furnished products and products identified under Allowances.

J. Revisions To Schedules:
   1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.

2. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
3. Prepare narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect including effect of changes on schedules of separate Contractors.

1.4 PROPOSED PRODUCTS LIST

A. Within 30 days after date of Owner-Contractor Agreement, submit list of major products proposed for use, with name of Manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give Manufacturer, trade name, model or catalog designation, and reference standards.

1.5 SUBCONTRACTOR LIST

A. Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
1. Name, address, and telephone number of entity perform subcontract or supplying products
2. Number and title of related Specification Sections(s) cover by Subcontractor
3. Drawing number and detail references, as appropriate, covered by subcontract

B. Submit three copies of Subcontractor list, unless otherwise indicated. Engineer will return two copies.
1. Mark up and retain one returned copy as a Project Record Document.

1.6 PRODUCT DATA

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

B. Product Data: Submit to Engineer/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

C. Submit number three Contractor copies, plus two copies Engineer/Engineer will retain.

D. Mark each copy to identify applicable products, models, options, and other data. Supplement Manufacturers' standard data to provide information specific to this Project.

E. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

F. Distribute copies after review.

1.7 SHOP DRAWINGS

A. Prior to submitting shop drawings, Contractor shall furnish Engineer with complete Shop Drawing Submittal Log. No Submittals will be reviewed until a complete Submittal Log has been submitted to Engineer.
   1. Contractor shall submit all required shop drawings and product data to the Engineer with reasonable promptness and in an orderly sequence so as to cause no delay in the work.
   2. Prepare and submit, with construction schedule, a separate schedule listing dates for submission and lead dates for reviewed shop drawings, product data and samples for each item.
   3. No extension of time shall be allowed because of failure to properly coordinate and sequence submittals.

B. Shop Drawings: Submit to Engineer/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Dimensions
      b. Identification of products
      c. Fabrication and installation drawings
      d. Roughing-in and setting diagrams
      e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring
      f. Shopwork manufacturing instructions
      g. Templates and patterns
      h. Schedules
      i. Design calculations
      j. Compliance with specified standards
      k. Notation of coordination requirements
      l. Notation of dimensions established by field measurement
      m. Relationship to adjoining construction clearly indicated
      n. Seal and signature of professional engineer if specified
      o. Wiring Diagrams: Differentiate between Manufacturer-installed and field-installed wiring
   2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 22 by 24 inches.
   3. Number of Copies: Submit five opaque copies of each submittal, unless copies are required for operation and maintenance manuals. Engineer will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Drawing

D. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. All work must ultimately comply with the contract documents unless Engineer/Engineer gives specific written acceptance of specific deviations.

F. Distribute copies after review.

1.8 SAMPLES

A. Samples: Submit to Engineer/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Samples For Initial Selection as Specified in Product Sections:
   1. Submit to Engineer/Engineer for aesthetic, color, or finish selection.
   2. Submit samples of finishes from full range of Manufacturers' standard colors, textures, and patterns for Engineer/Engineer selection.

C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

D. Include identification on each sample, with full Project information.

E. Submit number of samples specified in individual specification sections; Engineer/Engineer will retain two samples.
   1. Engineer will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project Record Sample.
   2. Retain one sample on construction site for field comparison as needed.

F. Samples will not be used for testing purposes unless specifically stated in specification section.

G. Distribute samples after review.

1.9 DESIGN DATA

A. Submit for Engineer/Engineer's knowledge as contract administrator or for Owner.

B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.10 TEST REPORTS

A. Submit for Engineer/Engineer's knowledge as contract administrator or for Owner.

B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.11 CERTIFICATES

A. When specified in individual specification sections, submit certification by Manufacturer, installation/application Subcontractor, or Contractor to Engineer/Engineer, in quantities specified for Product Data.

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

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

1.12 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer/Engineer for delivery to Owner in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.13 MANUFACTURER'S FIELD REPORTS

A. Submit reports for Engineer/Engineer's benefit as contract administrator or for Owner.

B. Submit report within 10 days of observation to Engineer/Engineer for information.

C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.14 ERECTION DRAWINGS

A. Submit drawings for Engineer/Engineer's benefit as contract administrator or for Owner.

B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer/Engineer or Owner.

1.15 PROJECT WARRANTY AND MAINTENANCE MANUAL:

A. Prior to final payment, the Contractor shall furnish two complete sets, in tabbed standard size ring binders, of equipment data, maintenance information, operations instructions, and warranties for equipment and systems provided under this contract. See Section 01700 for detailed requirements.

B. Provide warranties as specified. Warranties shall not limit length of time for remedy of damages Owner may have by legal statute. Contractor, Supplier, or Installer responsible for performance of warranty shall sign warranties.

C. Material Safety Data Sheets (MSDSs): Submit information directly to the City.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

PART 4 - ENGINEER'S/ACTION

4.1 General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.

B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

C. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

D. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality control and control of installation.

B. Tolerances.

C. References.

D. Labeling.

E. Mock-up requirements.

F. Testing and inspection services.

G. Manufacturers' field services.

H. Examination.

I. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply fully with manufacturers' instructions, including each step in sequence and secure Manufacturers certification as certified installer, when applicable.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to for a decision before proceeding.

E. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

F. Perform Work by persons qualified to produce required and specified quality. Perform Work by persons qualified to produce required and specified quality. The Contractor shall comply with applicable local, state, and federal codes and regulations.

1. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for or this Project, whose work has resulted in construction with a record of successful in-service performance.
2. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
3. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
4. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installation of the systems, assemblies, or products that are similar to those indicated for this Project in material, design, and extent.
5. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
6. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
7. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
8. Factory-Authorized Service Representative Qualifications: An authorized representative of Manufacturer who is trained and approved by Manufacturer to inspect installation of Manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

G. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

H. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

I. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work
   2. Incidental labor and facilities necessary to facilitate tests and inspections
   3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples
   4. Facilities for storage and field curing of test samples
   5. Delivery of samples to testing agencies
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency
   7. Security and protection for samples and for testing and inspecting equipment at Project site

J. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date for receiving bids, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

E. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5 LABELING

A. Attach label from agency approved by authority having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.

B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label.
   1. Model number.
   2. Serial number.
   3. Performance characteristics.

1.6 MOCK-UP REQUIREMENTS

A. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in location and of size indicated or, if not indicated, as directed by .
   2. Notify 14 days in advance of dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain 's approval of mockups before starting work, fabrication, or construction.
5. Allow seven days for initial review and each re-review of each mockup.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.7 TESTING AND INSPECTION SERVICES

A. Refer to Specifications Section 01 40 10 – Testing Laboratory Services.

B. Employ and pay for services of an independent testing agency or laboratory acceptable to Owner to perform specified testing.
   1. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time specialist and responsible officer.
   2. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.

C. The independent firm will perform tests, inspections and other services specified in individual specification sections and as required by Engineer and / or Owner.
   1. Laboratory: Authorized to operate at Project location.
   2. Laboratory Staff: Maintain full time registered Engineer on staff to review services.
   3. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

D. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by Engineer or Owner.

E. The work will be observed by the Engineer (Owner's Representative) or the Owners field observer and performed to his satisfaction in accordance with the Contract Plans and Specifications. The Owner's representative and Engineer will decide all questions which may arise as to the quality of acceptability of materials furnished and work performed; the manner of performance and rate of progress of the work; the interpretations of the contract plans and specifications; and the acceptable fulfillment of the contract on the part of the Contractor. The Owner's decisions will be final, and he will have executive authority to enforce and make effective such decisions and orders if the contractor fails to carry out the work promptly.

F. Reports will be submitted by independent firm to Engineer, the City Project Manager (2 copies) and Contractor, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

G. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

1. Notify Engineer and independent firm 48 hours prior to expected time for operations requiring services.
2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

H. Testing and employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

J. Agency Responsibilities:
1. Test samples of mixes submitted by Contractor.
2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
3. Perform specified sampling and testing of products in accordance with specified standards.
4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
6. Perform additional tests required by Engineer.
7. Attend preconstruction meetings and progress meetings.

K. Agency Reports: After each test, promptly submit two copies of report to Engineer and to Contractor. When requested by Engineer, provide interpretation of test results.

L. Limits On Testing Authority:
1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency or laboratory may not approve or accept any portion of the Work.
3. Agency or laboratory may not assume duties of Contractor.
4. Agency or laboratory has no authority to stop the Work.

M. Any materials and/or workmanship which are rejected by the Engineer by reason of failure to conform to the requirements of the plans or specifications shall be removed and replaced at Contractor's expense, including testing expense to correct faulty work.

N. Inspections and testing required by law, ordinances, rules and regulations or other public authorities are the responsibility of the Contractor. It is the sole responsibility of the Contractor to call for testing and any work not tested will be automatically rejected.

O. Contained in the various specification sections are requirements for certification of products, testing, adjusting, and balancing of equipment and other tests and standards. Testing is required for, but not limited to, the following items of work:
1. Soils-compaction control and hydrocarbon concentrations
2. Cast-in-place concrete
3. Concrete reinforcement
4. Asphalt pavement
5. Cement-Sand Backfill material

6. Crushed limestone base materials
7. Water and sludge
8. Other items in the Scope of Work

1.8 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel; provide access to the work area.

B. Provide to laboratory, preliminary representative samples of materials to be tested in required quantities.

C. Furnish labor and equipment:
1. To provide access to the work to be tested.
2. To obtain and handle samples at the site.
3. To facilitate inspections and tests.
4. For laboratory's exclusive use for storage and curing of test samples.

1.9 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment and as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Engineer 30 days in advance of required observations. Observer subject to approval of Engineer or Owner. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

C. Refer to Section 01 33 00 - Submittal Procedures, MANUFACTURERS' FIELD REPORTS article.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

3.3 TEST AND INSPECTION LOG

A. Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted
   2. Description of the Work tested or inspected
   3. Date test or inspection results were transmitted to
   4. Identification of testing agency or special inspector conducting test or inspection

B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for 's reference during normal working hours.

3.4 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
   2. Comply with the Contract Document requirements for Division 1 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Summary

B. Definitions

C. Submittals

D. Quality Assurance

E. Product Delivery, Storage and Handling.

F. Product Warranties.

G. Product Selection Procedures.

H. Product Substitution.

I. Comparable Products.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project.

B. Related Sections:
   1. Section 01 10 20 - Definition and Standards.
   2. Section 01 70 00 – Execution and Closeout Procedures
   3. Division 2 – 14, 21, 22-28, 31-33: Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities

related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.4 SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use form provided by Owner, reference Section 01 63 00 Substitutions and Product Options.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified material or product cannot be provided.
      b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners.
      g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
      h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
      i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
      j. Cost information, including a proposal of change, if any, in the Contract Sum.
      k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
      l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
   a. Form of Acceptance: Change Order.
   b. Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.

B. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
      a. Form of Approval: As specified in Section 01 33 00 "Submittal Procedures."
      b. Use product specified if Engineer cannot make a decision on use of a comparable product request within time allocated.

C. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.5 QUALTIY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

B. Delivery and Handling:
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage
   1. Store products to allow for inspection and measurement of quantity or counting of units.
   2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents. Venue for warranty legal issues shall be as stated in General Conditions.
   1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Refer to Division 2 – 14, 21, 22-28, 31-33 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 01 70 00 – Execution and Closeout Requirements.

PART 2 PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   4. Where products are accompanied by the term "as selected," Engineer will make selection.

5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Part 2 "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:
1. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
2. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
3. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
4. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
5. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
6. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
7. Visual Matching Specifications: Where Specifications include the phrase “as selected from manufacturer’s colors, patterns, textures” or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
   a. Standard Range: Where specifications include the phrase “standard range of colors, patterns, textures” or similar phrase, Engineer will select color pattern, or texture from manufacturer’s product line that does not include premium items.
   b. Full Range: Where Specifications include the phrase “full range of colors, patterns, textures” or similar phrase, Engineer will select color, pattern or texture form manufacturer’s product line that include both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

A. Reference Section 01 63 00 – Substitutions and Product Options

2.3 COMPARABLE PRODUCTS

A. Conditions: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements.

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
5. Samples, if requested.

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01 70 00
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Installation

B. Owner-Installed Products

C. Progress Cleaning

D. Closeout procedures.

E. Final cleaning.

F. Starting of systems.

G. Demonstration and instructions.

H. Testing, adjusting and balancing.

I. Protecting installed construction.

J. Project record documents.

K. Operation and maintenance data.

L. Manual for materials and finishes.

M. Manual for equipment and systems.

N. Spare parts and maintenance products.

O. Product warranties and product bonds.

P. Substantial Completion

Q. Final Completion.

R. List of Incomplete Items (punchlist)

S. Completed Final Punchlist Inspection

1.2 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling.

B. Comply with Manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

1.3 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction forces.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
2. Pre-installation Conferences: Include Owner's construction forces at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-

installation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

1.4 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of Manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

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

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

1.5 FINAL CLEANING

A. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instruction.

C. Conduct the following cleaning operations before requesting inspection for certification of Final Completion for entire or a portion of the Project:
   1. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   3. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   4. Remove tools, construction equipment, machinery, and surplus material from Project site.
   5. Remove snow and ice to provide safe access to building.
   6. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
   7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   8. Sweep concrete floors broom clean in unoccupied spaces.
   9. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
   10. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
   11. Remove labels that are not permanent.
   12. 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.
   13. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
   14. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
   15. Replace parts subject to unusual operating conditions.
   16. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
   17. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
   18. Clean ducts, blowers, and coils if units were operated without filters during construction.
      a. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
      b. Leave Project clean and ready for occupancy.

D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous

materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

1.6 STARTING OF SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Engineer and Owner 14 days prior to start-up of each item.

C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.

G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report in accordance with Section 01 33 00 - Submittal Procedures that equipment or system has been properly installed and is functioning correctly.

1.7 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of substantial completion.

B. Demonstrate Project equipment and instructed by qualified representative who is knowledgeable about the Project.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time at equipment location.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. Required instruction time for each item of equipment and system is specified in individual sections.

1.8 TESTING, ADJUSTING AND BALANCING

A. Refer to Mechanical and Electrical Specifications for specific requirements.

B. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or non-compliance with requirements of Contract Documents.

1.9 PROTECTING INSTALLED CONSTRUCTION

A. Provide for temperature and relative humidity as per manufacturer’s written instructions.

B. Protect installed Work and provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Prohibit traffic from landscaped areas.

1.10 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed Shop Drawings, Product Data, and Samples.
   6. Manufacturer's instruction for assembly, installation, and adjusting.
   7. Manufacturer’s certificates
   8. Reviewed Submittals

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Label and file Record Documents in accordance with Section number listings in Table of Contents of this Project Specifications Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.

E. Record information concurrent with construction progress, not less than weekly.

F. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by Addenda and modifications.

G. Record Drawings and Shop Drawings: Provide felt tip pens, maintaining separate colors for each major system, for recording information. Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish [first] [main] floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.
   6. Changes made by Addenda and modifications.
   7. References to related shop drawings and modifications.

H. Submit two copies of documents to Engineer prior to or on Substantial Completion inspection.
   1. Transmit with cover letter listing:
      a. Date
      b. Project title and number
      c. Contractor’s name, address, and telephone number.
      d. Number and title of each Record Document.
      e. Signature of Contractor or authorized representative.

1.11 OPERATION AND MAINTENANCE DATA

A. Submit data bound in 8-1/2 x 11 inch (A4) text pages, three D side ring binders with durable covers.

B. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.

C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

D. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

E. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
   1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
   2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
      a. Significant design criteria.
      b. List of equipment.
      c. Parts list for each component.
      d. Operating instructions.

e. Maintenance instructions for equipment and systems.
f. Maintenance instructions for [special] finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3: Project documents and certificates, including the following:
   a. Shop drawings and product data.
   b. Air and water balance reports.
   c. Certificates.
   d. Originals of warranties and bonds.

F. Submit two copies of documents to Engineer prior to or on Substantial Completion inspection.
   1. Transmit with cover letter listing:
      a. Date
      b. Project title and number
      c. Contractor's name, address, and telephone number.
      d. Number and title of each Record Document.
      e. Signature of Contractor or authorized representative.

1.12 MANUAL FOR MATERIALS AND FINISHES

A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes 15 days prior to substantial completion. Draft copy will be reviewed and returned with Engineer comments. Revise content of document sets as required prior to substantial completion.

D. Submit two sets of revised final volumes in final form before or on date of substantial completion

E. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. [Include information for re-ordering custom manufactured products.

F. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

G. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.

H. Additional Requirements: As specified in individual product specification sections.

I. Include listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

1.13 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes 15 days prior to substantial completion Draft copy will be reviewed and returned with Engineer comments. Revise content of document sets as required prior to substantial completion.

D. Submit two sets of revised final volumes in final form prior to or on date of substantial completion inspection.

E. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

G. Include color coded wiring diagrams as installed.

H. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and special operating instructions.

I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

J. Include servicing and lubrication schedule, and list of lubricants required.

K. Include manufacturer's printed operation and maintenance instructions.

L. Include sequence of operation by controls manufacturer.

M. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

N. Include control diagrams by controls manufacturer as installed.

O. Include Contractor's coordination drawings, with color coded piping diagrams as installed.

P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

Q. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

R. Include test and balancing reports as specified in Section 01 40 00 - Quality Requirements.

S. Additional Requirements: As specified in individual product specification sections.

T. Include listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.14 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.

B. Deliver to Project site and place in location as directed by Owner; obtain receipt prior to or on substantial completion inspection.

1.15 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.

C. Verify documents are in proper form, contain full information, and are notarized.

D. Co-execute submittals when required.

E. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual. Include Table of Contents and assemble in three D side ring binder with durable plastic cover.
   1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
   2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
   3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

F. Submit prior to or on substantial completion inspection.

G. For equipment or components parts of equipment put into service during construction or For items of Work for which acceptance is delayed beyond Date of Substantial Completion refer to the Building General Conditions.

1.16 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
   1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.

3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
8. Complete startup testing of systems.
9. Submit test/adjust/balance records.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
15. Complete work on items listed on Punch Lists.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
   1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for Final Completion.

1.17 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
   1. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   2. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.18 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use CSI Form 14.1A or form acceptable to the Owner and Engineer..
   1. Organize list of spaces in sequential order, starting with exterior areas first.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Engineer.
      d. Name of Contractor.
      e. Page number.

1.19 COMPLETED FINAL PUNCHLIST INSPECTION

A. Correct or complete all items on the punchlist before requesting final payment. Unless otherwise agreed upon, the contractor has seven (7) days of receipt of final punchlist. When the final punchlist is complete and the Contract is fully satisfied according to Contract Documents, a certificate establishing the date of Final Completion will be issued.

B. Refer to the Building General Conditions for Owner’s right to complete the work in the event the contractor does not complete the final punchlist.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 23 00 00
MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Except as modified in this section, General Conditions, Supplementary Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23, HVAC.

B. Applicable provisions of this section apply to all sections of Division 23, HVAC.

C. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details of special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.

1.2 CODE REQUIREMENTS AND PERMITS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

1.3 REFERENCE SPECIFICATIONS AND STANDARDS

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material, and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

1.4 CONTRACTOR QUALIFICATIONS

A. An acceptable contractor for the work under this division shall be a specialist in this field and have the personal experience, training, skill and the organization to provide a practical working system. If required, he shall be able to furnish acceptable evidence of having contracted for and installed not less than three systems of comparable size and type to this one, that have served their owners satisfactorily for not less than three years.

B. The foreman for this work shall have had experience in installing not less than three such systems and shall be approved before the work is begun. Adequate and competent supervision shall be provided to ensure first class workmanship and installation.

C. Work shall be executed and all materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed. Work shall be performed by mechanics skilled in the trade.

D. The Contractor shall be responsible for all construction techniques required for all mechanical systems specified and shown on the drawings.

1.5 REQUEST FOR INFORMATION

A. The Contractor may, after exercising due diligence to locate required information, request from the Consultant clarification or interpretation of the requirements of the Contract Documents. The consultant shall respond to such Contractor's requests for clarification or interpretation. However, if the information requested by the Contractor is apparent from field observations, is contained in the Contract documents or is reasonably inferable from them, the Contractor shall be responsible to the Owner for all reasonable costs charged by the consultant to the Owner for the Additional Services required to provide such information.

1.6 CONTRACT DRAWINGS

A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work or show all offsets or required fittings. Determine exact locations from field measurements. Making adjustments to field conditions is considered a part of the work required.

B. When the mechanical and electrical Contract Documents do not give exact details to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grade for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Contract Documents do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

C. Prior to locating mechanical equipment, plumbing fixtures, water heaters, water coolers and other plumbing or mechanical items, obtain approval as to exact method and exact placement and location of equipment in the various areas shown on the drawings. In no case shall the locations be determined by scaling the drawings. Plumbing fixtures shall be mounted at the heights directed by the Architect and local code authorities. Relocate equipment and devices and pay all costs of modifying work of all trades necessitated by failure to comply with this requirement.

D. These specifications are accompanied by drawings of the building and details of the installation indicating the locations of equipment, piping, ductwork, outlets, switch controls,

circuits, lines, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.

E. It is the Contractor's responsibility to properly use all information found on the Architectural, Structural, Mechanical and Electrical Drawings where such information affects his work.

F. The drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the general drawings and to all detail drawings, equipment drawings, rough-in drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

G. Should the drawings or specifications disagree within themselves, or with each other, the better quality or greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Architect in writing, shall be performed or furnished.

1.7 OFFSETS

A. The Contract Documents are diagrammatic as stated above. Not all offsets are shown. This applies to all ductwork, piping, flues, or any other component that is routed underground or throughout the structure. The Contractor shall be responsible to layout all piping in a manner that allows for complete maintenance access. Contractor shall provide and install, without additional costs, <u>all</u> offsets necessary to complete this project and to provide a complete, working, accessible, and maintainable system.

1.8 BUILDING DEMOLITION

A. Unless noted otherwise, remove all mechanical materials and equipment from areas designated for demolition.

B. Where mechanical equipment is indicated for removal, the Contractor shall remove all associated piping, controls, etc. Where abandoned piping is concealed in walls, floors or ceilings the exposed portion of the abandoned piping shall be cut off flush with the building surface and the concealed portion shall be capped and abandoned in place. All voids left by the removal of mechanical equipment shall be filled with grout and finished to match existing adjacent surfaces. Removal of any mechanical equipment shall be performed in such a way not to interfere with ongoing daily building operations.

C. All salvage shall remain the property of the Owner and be delivered to a location, on site, as designated by the Owner. In the event the Owner does not desire to retain the salvage material, the material becomes the property of the Contractor and shall be disposed of by the Contractor.

D. Existing mechanical services and controls to items being removed by others must be disconnected as a requirement of this section.

E. Wherever a new to existing mechanical connection is required, the Contractor shall provide all materials and labor required to make the connections.

F. The Contractor shall be responsible to maintain all mechanical systems, in an operational condition, in all areas not included under this contract that may be affected during the demolition.

G. All concrete slab penetrations shall be coordinated and approved by the structural engineer. The Contractor shall X-ray the proposed slab penetration area prior to performing any work, to ensure that there are no existing conduit systems, concrete load bearing structural members, etc., that may otherwise be damaged by core drilling the concrete slab.

H. Equipment and devices not scheduled for removal and their associated mechanical systems shall remain in their original operating condition.

1.9 MOTORS CONTROLLED BY VFD

A. General Requirements - Shaft Grounding:

1. All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge damaging shaft voltages away from the bearings to ground, AEGIS Bearing Protection Ring.

2. Application Note: Motors up to 100HP shall be provided with one shaft grounding ring installed either on the drive end or non-drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

B. General Requirements - High Frequency Bonding:

1. All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection.

2. Application Note: Proper grounding of motor frame for all inverter-driven induction motors.

(a) References:

ABB Technical Guide No. 5
Allen Bradley Publication 1770-4.1 Application Data, Industrial Automation Wiring and Grounding Guidelines

PART 2 - PRODUCTS

2.1 Per Senate Bill 1289 passed in 2017, all state entities are required to provide all iron and steel products to be manufactured in the United States.

PART 3 - EXECUTION

3.1 Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

3.2 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions which have been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.

B. Before any cutting or trenching operations are begun, verify with Owner's representative, utility company, municipalities, and other interested parties that all available information has been provided. Verify locations given.

C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

D. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.3 CUTTING AND PATCHING

A. The Contractor shall be responsible for timely placing of all equipment and piping to avoid cutting new construction.

3.4 OPENINGS

A. Framed, cast or masonry openings for piping or equipment is specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.5 COORDINATION

A. Contract Documents are diagrammatic in showing certain physical relationships to other trades. Interface and coordination with other work including utilities and electrical work is the exclusive responsibility of the contractor.

B. Contractor shall coordinate with Division 26 and other divisions as required. This is to include but not be limited to verification of power, voltage, phase and other characteristics as being compatible with that called for on the electrical drawings and Division 26 specifications, as well as that called for in Division 23 drawings and specifications or other divisions requiring electrical connections or interface with this division. This shall be done prior to placing orders for equipment. Controls contractor to coordinate with electrical contractor for all required 120 volt power for all DDC panels, 120 volt motor actuators, 120 volt motorized dampers, etc. prior to bids. If it is not coordinated prior to bid, mechanical is responsible for <u>all</u> 120 volt conduit, breakers, conductors, etc.

C. Arrange mechanical work in a neat, well organized manner with services running parallel with primary lines of the building construction, and with the maximum overhead clearance possible.

D. Locate operating and control equipment properly to provide easy access. Arrange entire mechanical work with adequate access for operation and maintenance.

E. Advise other trades of openings required in their work for the subsequent move-in of large units of mechanical work.

F. Verify exact locations of existing equipment and determine exact requirements for connections prior to routing services to equipment.

3.6 CONCEALED WORK

A. Where the word "concealed" is used in connection with insulating, painting, piping, ducts and the like, the word is understood to mean hidden from sight as in chases, furred spaces or suspended ceilings. "Exposed" is understood to mean open to view.

3.7 PROTECTION

A. The Contractor shall be responsible for the protection of all materials and equipment to be installed under this Division from physical and weather damage.

B. Provide all hoisting and scaffolding equipment required for proper installation of equipment. The contractor shall take full responsibility for the safety of the materials and equipment using such hoisting equipment and scaffolding.

C. Adequately protect work, equipment, fixtures, and materials. At work completion, all work shall be clean and in good condition.

3.8 AIR FILTERS AND PIPE STRAINERS

A. Immediately prior to final acceptance of project, clean and service strainers and replace disposable type air filters. If air handling units are operating during construction, install high efficiency filters in units and replace at end of construction. High Efficiency filters in the air handling units consist of minimum 1" pleat Camfil 30/30 prefilter. As far as plenum exposed heating coils in fan powered VAV boxes, the plenum inlet shall have a minimum 1" pleat Camfil 30/30 filter with a prefilter attached (preferably, the contractor will cover the inlet when debris is present). However, if the air units, fans, VAV boxes are operated during construction, and if the fan wheels, fan housings, coils, etc. are fouled by dust or debris, the Contractor, at his expense, shall clean all fouled components.

3.9 GUARANTEE

A. Guarantee work for 1 year from the date of final acceptance of the project and during that period make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship.

3.10 MATERIALS AND EQUIPMENT

A. Furnish new and unused materials and equipment of Domestic Manufacturers meeting requirements of the paragraph specifying acceptable manufacturers. Where two or more units of same type or class of equipment are required, provide units of a single manufacture.

3.11 ACCEPTABLE MANUFACTURERS

A. The following is a list of acceptable manufacturers for items of equipment specified under Division 23, Mechanical. Manufacturers names and catalog numbers specified under sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a manufacturer named below will be acceptable on approval.

B. A request for prior approval of equipment not listed must be submitted 14 days before bid due date. Only manufacturers specified in sections of Division 23, on drawings or listed below (including subsequent addenda) will be acceptable. There will be no exceptions to this requirement. Submit complete design and performance data to the Architect.

Item	Manufacturer
Access Doors	Inryco/Milicor, Karp
Insulation	Certainteed, Johns-Manville, Knauf, Owens-Corning, Kingspan
Expansion Tanks	Taco, Wood Industrial, Amtrol
Controls	Johnson, Siemens, Carrier
Roof Top Air Conditioning Units	Carrier, Trane, York
Filters	American Air Filter, Farr
Vibration Isolation	Amber-Booth, Mason Industries
VAV Boxes	Price, Titus, Carrier
Air Cooled Condensing Units/ Heat Pumps	Carrier, Trane, York
Variable Frequency Drives	ABB, Danfoss, Magnatek, Robicon, Carrier
Air Handling Units	Trane, York, Carrier
Thermometers and Gauges	Ashcroft, Dwyer, Marsh, Trerice
Flexible Duct	Flexmaster (only)

C. Manufacturers listed in schedules, on the drawings or in a specific section of the specifications for a specific product is the basis of design. Any other submitted product will

be construed to be a proposed substitute, even if listed in the acceptable manufacturers list, and must comply with the following paragraphs.

D. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the contract documents, unless the attention of the Architect has been directed in writing to the deviations.

E. Each proposed substitute shall be referenced to the trade name of the specified product, and the paragraph and page number of the specifications where the specified items occur. Each proposed substitute shall be accompanied by adequate supporting information including catalog cuts, diagrams, representative samples, published ratings, drawings, and other such descriptive information as may be required to properly illustrate the complete characteristics of materials and equipment. In addition, a detailed statement indicating item-by-item and paragraph-by-paragraph wherein the product to be offered deviates from the specification shall be submitted for each proposed alternate. Any such alternate proposal must include all necessary changes and additions to other work occasioned by such substitution. In addition, each alternate proposal must stipulate that the substituted product will fit the space allotted the specified product and provide the same or greater clearances for maintenance, removal and/or access.

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

G. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactorily for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

3.12 SUBMITTAL DATA AND SHOP DRAWINGS

The submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of the specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the specified system performance. This is to be included with each submittal.

A. Submittal data. Submit descriptive literature, physical data, and performance data by the appropriate specification section or the specific sheet where products are shown on the contract drawings that are not referenced by the specification for review. All specification sections require a submittal. Submit each spec section separately but at one time. Submittals can be contained in one binder or binders, however, each specification section must be submitted as a single submittal and each section must be clearly marked or tagged with the specification section number. Each submittal shall bear the specification section number it is related to. Any submittal received without referring to the appropriate specification section number will be returned without review. Include identifying symbols and equipment

numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted. Submittal data shall specifically list all proposed deviations from the contract documents. Submittals that are not clearly marked will be rejected for that reason.

B. Contractor's Check. Shop drawings and submittal data will be submitted only by the Contractor. Indicate by signed stamp that the drawings and submittal data have been checked, that the work shown on the drawings and submittal data is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings and submittal data are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect.

C. Equipment Rooms. Submit shop drawings of mechanical equipment rooms, mechanical yards, and HVAC closets, and where directed, other complex areas. Shop drawings shall include plan views and elevations, show actual equipment to be installed, with piping fully detailed to show clearances, headroom, pipe routing, valve positions, pipe hangars, insulation, and other pertinent information. Prepare drawings to a scale of at least 3/8 inch per foot.

D. Coordination Drawings: Coordination Drawings in electronic media and hard copy shall be prepared by the Contractor indicating Mechanical, Plumbing, Fire Protection, Electrical work, low voltage cable management systems (or cable tray, as applicable) miscellaneous steel for the general work, lights, air devices, speakers, ceiling heights, etc., drawings shall indicate all duct work, mechanical lines 2" and greater (except all lines that require gravity draining are to be shown), all plumbing lines 2" and greater, trunk lines of fire protection system, and all sprinkler heads. Electrical conduit 2" and greater as well as pull boxes or other elements over 6" x 6" shall be shown. Major pieces of equipment by all trades are to be indicated.

Coordination drawings shall depict the routing of all above ceiling items and shall identify elevations of these items as necessary to fit above specified ceiling systems. Preparation of section details at certain congested corridor locations will be required. The Contractor shall identify which, if any, above ceiling items cannot be installed as schematically shown on the Contract Documents and shall timely notify the Designer of these items with proposed resolution. Contractor shall submit to the designer a complete set of coordination drawings for all of this project, showing non-conflicting routing of all above-ceiling items. No above-ceiling installations shall proceed in any project area until the coordination drawing for that area is completed. These drawings shall bear the original signature of all Contractor (trade) superintendents, indicating that they agree with the routing of above-ceiling items shown. Dimensions are not required and will not be reviewed. Spool drawings are not required. Showing pipe joints and duct joints is not required or desired and will not be reviewed.

It is preferred that the Contractor provide these services with in-house personnel. If this is not possible, Contractor must submit at least two (2) firms or individuals proposed to provide these documents. The Engineer will advise the Contractor which firm or individual is acceptable, prior to services being procured. The Contractor‘s bid shall include all costs for those services noted herein.

1. Upon completion of coordination drawings, the project manager or superintendent for the HVAC, and Electrical trades shall be required to sign each sheet of the coordination drawings. Signature shall attest to a diligent review and agreement to alleviate future space conflicts at no cost to the Owner. Any trade that installs elements of its work in locations other than those indicated on the coordination drawings that impacts the work of other trades, or installs elements of its work that is not shown on the coordination drawings, the trade in violation of the coordination drawings shall be required to either:

   (a) Move his work to resolve the conflict, or

   (b) Reimburse the affected trade(s) to move his work to resolve the conflict, or

   (c) Reimburse the Owner to move his work to resolve the conflict.

   For record only, Coordination Drawings must be complete and submitted to the Designer within 90 days of award of contract. No review or approval will be forthcoming. Coordination drawings are required for the benefit of the Contractor and all trades as an aid to coordination of their work so as to eliminate or reduce conflicts that may arise during the installation of their work.

   Copies of the project coordination drawings shall be submitted as part of the required closeout document package.

Owner:	1 copy
Architect:	1 copy
MEP Engineers:	1 copy

E. Engineer's approval of submitted material constitutes an acknowledgment only and in no way relieves the contractor of full responsibility for providing all systems complete in accordance with the intent of the drawings and specifications. Contractor is responsible for confirming and correlating dimensions at job site, for information which pertains to fabrication processes or construction techniques and for coordination of work with all other trades. Any materials or equipment provided by this contractor without approved shop drawings constitutes the contractor's agreement to comply with the engineer's intent whether specified, shown or implied.

3.13 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Secure three copies of operating and maintenance instructions, service manuals, and parts listed applicable to each item of equipment furnished. Deliver three bound sets for the Owner's use. Include nameplate data and design parameters in operation and maintenance manuals. Clearly distinguish between information which applies to the equipment and information which does not apply. Also include all approved submitted data, all warranties on equipment, contractor's warranty and all test and balance reports. Delivery of required documents is a condition of final acceptance.

B. Upon completion of work, and at time designated by the Engineer, provide services of a competent representative of the contractor for a period of at least 24 hours to instruct the owner's representative in the operation and maintenance of the entire system.

3.14 PROJECT RECORD DOCUMENTS

A. Preparation. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, traps, equipment, and other pertinent items, as installed. Include flow-line elevation of sewer lines. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.

B. Deliver. At conclusion of project, obtain without cost to Owner, sepias of original mechanical drawings and transfer as-built changes to these. Delivery of as-built prints and reproducibles is a condition of final acceptance.

C. Throughout progress of the work of this Contract, maintain an accurate record of all changes in the Contract Documents. Upon completion of the Work of this Contract, transfer the recorded changes to the AutoCAD drawing files and specification word processing files. Delegate the responsibility for maintenance of Record Documents to one person on the Contractor's staff. Thoroughly coordinate all changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to properly show the change. Include all addenda items, request for information Architect's Supplemental Instructions and any other document that causes a change in the Construction Documents. Accuracy of records shall be such that future search for items shown in the Contract Documents may reasonably rely on information obtained from the approved Record Documents.

D. The Contractor shall mark any deviations on a daily basis. The Architect will visit the site and will require to see the "As-Built" documentation periodically. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Record installed feeder conduits. Dimension the location and elevation of the conduit.

E. Record Documents shall consist of the following:

1. Job Set: Promptly following award of Contract, secure from the Architect, at no charge to the Architect, one complete set of all mechanical documents comprising the Contract.

2. Final Record Documents: Obtain the AutoCAD drawings files at the Contractor's expense (<u>$200</u> and signed release form).

(a) The Contractor shall transfer all change data shown on the job set of to the corresponding electronic files, coordinating the changes as required, and clearly indicating at each affected detail and other drawing the full description of all changes made during construction and the actual location of items. Call attention to each entry by drawing a "cloud" around the area or areas affected.

3. Submit the completed total set of Record Documents to the Engineer as described above. Participate in review meeting or meetings as required by the Engineer, make all required changes in the Record Documents, and promptly deliver the final Record Documents to the Architect. Upon completion of Work, the Contractor shall certify the "Record Drawings" for correctness by signing the following certification:

CERTIFIED CORRECT (3/8" high letters)

(Name of the Contractor)

By _____

Date _____

(Name of the Sub-Contractor)

By _____

Date _____

F. Deliver record drawings to the Architect in the number and manner specified in Division 01 - General Requirements.

3.15 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.

3.16 OPERATING TESTS

A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections.

3.17 LUBRICATION, REFRIGERANT AND OIL

A. Provide a complete charge of correct lubricant for each item of equipment requiring lubrication.

B. Provide complete and working charge of proper refrigerant, free of contaminants, into each refrigerant system. After each system has been in operation long enough to ensure completely balanced conditions, check the charge and modify it for proper operation as required.

3.18 EQUIPMENT NAMEPLATES

A. All air handling units, fan-coil units, air terminal boxes, VAV boxes, and condensing units shall have an engraved Setonply Nameplate, black background, white letters, 1-1/2" x 4". Nameplate shall have equipment mark (same as indicated on drawings) in white. Plate shall be attached to equipment without using screws, per manufacturer's recommendations. All fans shall have an engraved aluminum plate with fan number, black background, white letters, 3/4" x 2-1/2". Fan nameplate shall also list rooms served by fan on one line and the service on the third line. Attach to fan per manufacturer's recommendations.

3.19 SUBSTITUTIONS REQUIRING CHANGES

A. Manufacturers and power requirements indicated on the mechanical and electrical drawings are the basis of design. If changes are required for the equipment submitted, such as changes in conduit size, conductors, breakers, disconnects, panels, etc., it shall be made at no additional cost to the Owner.

3.20 AIR BALANCE

A. Contractor shall provide an air balance of all ducted systems. Adjust sheaves, belts, drives, dampers, etc., to obtain air quantities shown. Verify proper operation of all systems. Verify all volume dampers are installed. Perform TAB operations as required by the NEBB Test and Balance Procedures Manual and Record Tests (of all ducted systems) in a report and submit to the Architect for review.

3.21 CONTROLS

A. Provide and install all wiring, conduit and other devices required for a complete and working HVAC system, including all interlocks and stop/start wiring from time clock. This includes but is not limited to 120 volt and low voltage wiring. Materials and method of execution are specified in Division 26 - Electrical.

B. Provide a motorized low leakage volume damper for outside air to each unit. Volume damper shall close when air-unit is de-energized.

3.22 PIPE SLEEVES

A. Fit with sleeves all pipes passing through masonry and concrete construction. Fabricate sleeves of schedule 40 galvanized steel pipe. Size sleeve for minimum clearance between pipe or insulation and sleeve.

B. Extend each sleeve through the floor or wall. Cut the sleeve flush with each surface, except that in exposed locations, extend floor sleeves 3 inches from finished wall or above finished floor line.

C. Caulk all sleeves water and airtight. Seal annular space between pipes and sleeves with fire stop material, see specification on fire stopping found elsewhere in this specification. Install per manufacturer's recommendations to meet or exceed fire rating of penetrated wall (minimum 1-1/2 hour). Reference architectural drawings for wall fire ratings.

D. Sleeve pipe through concrete foundations, below grade with Thunderline Link-Seal wall penetration seals. Equip seals with stainless steel nuts , bolts and pressure plate.

3.23 FIRESTOPPING

A. All piping, tubing, ductwork, conduit, etc. passing through fire rated floors and/or walls shall have the void area between the material passing through floor and/or wall sealed with an approved fire-stop material to maintain the fire rating of the floor and/or wall. Depending on the particular installation, the contractor shall use FS900 series fire stop caulk or FS500/600 series fire-stop components as manufactured by International Protective Coatings or approved equivalent.

B. All fire stop systems shall be installed as required by the manufacturer and U.L. requirements for each application.

C. The Contractor shall procure the services of an independent inspection service to review and provide a certified letter to the Contractor, Engineer and the City of Austin, stating all firestopping has been installed per UL listing and the manufacturer's recommendations. Independent service shall have experience in the inspection of firestopping materials and methods installed.

3.24 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities as used by his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices and receive written permission from the Owner to enter existing areas. Before beginning work in existing areas, make the necessary arrangements and perform other services required for the care, protection, and in service maintenance of all electrical, communication, plumbing, heating, air conditioning, and ventilating services for existing facilities. The Contractor shall erect temporary barricades with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

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

C. Where existing construction is removed to provide working and extension access to existing utilities, the 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.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed and equipment located in these areas is required to remain in operation, the Contractor shall remove and reinstall all equipment required for the operation of the remaining electrical systems. This is to include but is not limited to electrical switches, relays, fixtures, conduit, etc.

3.25 OUTAGES

A. Outages of services as required by the project will be permitted but only at time approved by the Owner. The Contractor shall notify the Owner in writing two weeks in advance of the requested outage in order to schedule required outages. No outages shall be taken unless

written approval has first been received from the Owner. 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.

END OF SECTION

SECTION 23 05 29
EQUIPMENT SUPPORT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies furnishing and installation of concrete equipment pads for all direct and isolated floor mounted equipment, and structural equipment supports for horizontal tanks, heat exchangers and similar equipment, where required.

1.2 RELATED WORK

A. Division 03 - Cast-in-Place Concrete.

B. Division 05 - Miscellaneous Metals.

C. Division 09 - Painting.

D. Division 23 - HVAC. Inertia blocks are specified in the section on Vibration Isolation.

1.3 SUBMITTALS

A. Submit shop drawings on all structural supports in accordance with Division 01 - General Requirements.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Provide Class A concrete as specified in Division 03 - Concrete.

2.2 STRUCTURAL METAL

A. Furnish structural metal as specified in Division 05 - Metals.

PART 3 - EXECUTION

3.1 CONCRETE PADS

A. Pour 4-inch pads on roughened floor slabs unless otherwise noted. Extend outer edges of pads a minimum of 2 inches beyond equipment. Secure equipment with anchor bolts in accordance with equipment installation instructions.

3.2 STRUCTURAL SUPPORTS

A. Construct floor stands of structural members or steel pipe. Bolt the floor stands to 6-inch concrete pads.

B. Install ceiling-mounted equipment from suitable brackets, platform framing or similar supports fabricated of structural members.

C. Paint all steel with minimum two coats of primer. Finish coats shall be in accordance with Division 09.

3.3 FAN AND EQUIPMENT SUPPORTS

A. If fan curbs or equipment curbs are not furnished with the equipment, provide prefabricated roof curbs, compatible with the roofing system installed (metal material to be modified if required); slope curbs for sloped roofs so top of curb is parallel with floor below (level). Curbs to be similar to Thycurb model TEMS; attenuated curbs to be similar to Thycurb model TC-VB (24" height). All seams and joints to be welded and hot dip galvanized. No shop fabricated products allowed.

3.4 VIBRATION ISOLATION ROOFTOP AIR CONDITIONING UNIT CURBS

A. Curbs to be compatible with roof system installed (metal material to be modified if required) and customized as required such that curb is level on sloped roofs. Curb to be similar to Thycurb Vibro-Curb II, optional support, 3" deflection, acoustical framing package, 19" height, air-tight plenum packaged, sized to match requirements of equipment it supports, including penetrations. All seams and joints welded and hot dip galvanized. No shop fabricated products allowed.

END OF SECTION

SECTION 23 05 48
VIBRATION ISOLATION

PART 1 - GENERAL

Refer to Section 23 00 00 for General Requirements for Mechanical Work.

1.1 SCOPE OF WORK

A. Unless otherwise noted on the equipment schedule, all mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. Vibration isolators shall be selected in accordance with weight distribution so as to produce reasonably uniform deflection. Deflections shall be as noted on the equipment isolator schedule noted herein.

C. All vibration isolation devices, including steel bases/forms shall be designed and furnished by a single manufacturer or his qualified representative.

D. All equipment is to be externally isolated to ensure that all paths of vibration have been addressed. **Internal Factory Isolation Is Unacceptable.**

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Refer to the section on Ductwork for flexible connections between fans and ducts.

2. Refer to the section on equipment Supports for equipment foundation pads.

1.3 SUBMITTALS

A. Submit product data showing type, size, load, deflection and other information required. Include clearly outlined procedures for installing and adjusting isolators.

B. Completely detail concrete bases including the 6-inch-thick foundation pad.

PART 2 - PRODUCTS

2.1 ISOLATOR DESIGN

A. Materials. Design and treat vibration isolators for resistance to corrosion. Furnished phosphatized steel components with industrial-grade, corrosion-resistant material. Coat components exposed to the weather with PVC coating or fabricate of galvanized steel. Furnish zinc electroplated nuts, bolts and washers. Clean steel bases thoroughly of welding slag and prime with zinc-chromate or metal etching primer.

B. Design.

1. Unless otherwise instructed, use spring-type vibration isolators for all equipment driven by motors of 3 horsepower and larger. The isolator manufacturer must calculate the amount of spring deflection required for each isolator to achieve optimum performance and to prevent the transmission of objectionable vibration and noise.

2. All spring isolators must be completely stable in operation and must be designed for not less than 30% reserve deflection beyond actual operating condition.

3. Design isolators for equipment installed outdoors to provide adequate restraint due to normal wind conditions. The isolators must withstand wind loads of 30 pounds per square foot applied to any exposed surface of the isolated equipment.

4. Air handling equipment subjected to excessive horizontal air thrust shall be furnished with isolated thrust resisters to limit displacement to 1/4 inch.

5. Height saving brackets used with isolators having 2-1/2-inch deflection or greater shall be of the precompression type to limit exposed bolt length.

2.2 ISOLATOR TYPES

A. Type MH-1 Mountings

1. Neoprene mountings shall have a minimum static deflection of 0.35”. All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the Overhang. Mountings shall be type ND or rails type DNR as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

B. Type MH-2 Mountings

1. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cap or ¼” neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLF, as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

C. Type MH-3 Mountings

1. Equipment with large variations in the operating and installed weight, such as chillers, boilers, etc., and equipment exposed to the wind such as cooling towers, roof mounted fans and roof mounted air handling equipment shall be mounted on spring mountings, as described in Engineering Specification B, including the neoprene acoustical pad within a rigid sided housing that includes vertical limit stops to prevent spring extensions when weight is removed and temporary steel

spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the springs shall be adjusted to assume the weight and the spacers removed, without changing the installed and operating heights. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 0.75" larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 0.5" to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation. Cooling tower mounts are to be located between the supporting steel and the roof or the grillage and dunnage as shown on the drawings when there is no provision for direct mounting. Housings and springs shall be powder coated and hardware electro-galvanized. Mountings shall be SLR as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

D. Type MH-2 Hangers

1. Vibration hangers shall contain a steel spring and 0.2" deflection neoprene element is series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be type **DNHS** as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

E. Type MH-4 Horizontal Thrust Restraints

1. When total air thrust exceeds 10% of the isolated weight, floor mounted or suspended air handling equipment shall be protected against excessive displacement by the use of horizontal thrust restraints. The restraint shall consist of a modified Specification B spring mounting. Restraint springs shall have the same deflection as the isolator springs. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of ¼" movement from stop to maximum thrust. The assemblies shall be furnished with rod and angle brackets for attachments to both the equipment and duct work or the equipment and the structure. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit. Horizontal thrust restraints shall be WB as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

F. Type R-1 All-Directional Acoustical Pipe Anchors

1. All directional acoustical pipe anchors, consist of two sizes of steel tubing separated by a minimum ½" thickness of 60 durometer or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 500 psi and the design shall by balanced for equal resistance in any direction. All directional anchors shall be type ADA as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

G. Type R-2 Acoustical Pipe Guides

1. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum ½ thickness of 60 durometer or softer neoprene. The height

of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of ±1 $^{5}/_{8}$" motion, or to meet location requirements. Pipe guides shall be type VSG as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

H. Type IB-1 Bases

1. Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells.

2. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6". Forms shall include minimum concrete reinforcement consisting of 3/8" bars or angles welded in place on 6" centers running both ways in a layer 1½" above the bottom, or additional steel as is required by the structural conditions. Height saving brackets shall be employed in all mounting locations to maintain a 2" clearance below the base. Bases shall be type KSL/BMK as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

I. Type RSC-1 Rooftop Spring Curb

1. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removal steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of ¼" thick. Steel springs shall be laterally stable and rest on ¼" thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" of insulation. Curb shall be type RSC as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

J. Type FC-1 for Following: Locations Within MER & Water Applications up to 180 Degrees

1. Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Size 1½" through 14" shall have a ductile iron external ring between the two spheres. Sizes 16" through 24" may be single sphere. Sizes ¾" through 2" may have one sphere, bolted threaded flange assemblies and cable retention.

2. Minimum ratings through 14" shall be 250psi at 170°F and 215psi at 250°F. 16" through 24" 180psi at 170°F and 150psi at 250°F. Higher published rated connectors may be used where required.

3. Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.

4. The piping gap (distance between companion flanges) shall be equal to the length of the expansion joint under pressure. Control rods passing through ½" thick Neoprene washer bushing large enough to take the thrust at 1,000psi of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

K. Type FC-2 – (Steel Pipe) for Following: Locations Outside MER, Water Applications (over 180 degrees), Air and Steams

1. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples.

2. Length shall be as tabulated:

FLANGED		MALE NIPPLES	
3 X 14	10 X 26	½ X 9	1½ X 13
4 X 15	12 X 28	¾ X 10 2 X 14	
5 X 19	14 X 30	1 X 11 2½ X 18	
6 X 20	16 X 32	1¼ X 12	
8 X 22			

Hoses shall be type BSS or UPCS furnished by As furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

L. Type FC-3 – (Copper Lines)

Flexible bronze hose shall have bronze braid with sweat connections for copper piping up to 3" diameter. Above 3" diameter, both hose and braid shall be stainless steel with brass sweat ends.

2.3 APPLICATION

A. Horizontal Pipe Isolation

1. Isolate piping as follows to create a floating mechanical system:

(a) Piping 1½" and larger, connected to isolated equipment in the central plant and mechanical equipment rooms.

(b) Pumped water and refrigerant piping 2" and larger outside mechanical equipment rooms.

2. To create a floating piping system, install piping hangers at regular intervals according to pipe hanger schedule. Coordinate selection of piping supports with equipment supports to accommodate expansion and contraction without creating excessive stresses at equipment connections.

3. For the two supports nearest a piece of equipment on each pipe connected to the equipment, select isolators with an operating spring deflection not less than that specified for the equipment isolators. All other supports for horizontal piping must have a minimum operating deflection of ¾" with a capability of an additional 50% travel-to-solid.

B. Vertical Riser Isolation

1. All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. The initial spring deflection shall be a minimum of 0.75" or four times the thermal movement at the isolator location, whichever is greater. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions. Submittal must by stamped and signed by a licensed professional engineer in the employ of the vibration vendor for at least 5 years. The isolator manufacturer shall be the same firm supplying the mechanical contract. Support spring mountings shall be MH-3, anchors Specification R-1, telescoping guides Specification R-2.

2.4 ISOLATOR APPLICATIONS

EQUIPMENT	BASE TYPE	FLEX TYPE	ISOLATOR TYPE	DEFLECTION
Packaged AHU:				
Indoors	***	* FC-1/2	MH-2	1.50"
Rooftop (Curb Mounted)	RSC-1	* FC-1	MH-2	2.50"
Fan Coil Units	—	FC-2	MH-2	0.75"
Fan Power Boxes	—	FC-2	MH-2	0.75"
Condensing Units/Condensers	—	* FC-1/2	MH-3	1.50"
Piping	(Refer to Specification Paragraph for Requirements)			

* Note Location, Temperature and Pressure Limitations noted in Specification Paragraphs listed above.

** If System Static Pressure is 3.5 inches or greater, install Horizontal Thrust Restraints MH-4.

*** Where necessary, unit manufacturer shall provide base rail assembly to allow attachment of external isolators.

2.5 PIPING

A. Provide a floating piping system in the central plant and in all mechanical rooms. To create a floating piping system, install piping hangers at regular intervals according to the pipe hanger schedule. Where floor supports are required provide sufficient spring capacity to absorb expansion and contraction of piping and yet, to permit piping to function as a floating system. Size hangers for 200% rated load. Size isolators for a minimum of 1-inch static deflection. Provide Amber/Booth Type BS or BSS spring hangers and Type SW-1 support isolators. Coordinate selection of piping supports with equipment supports to accommodate expansion and contraction without creating excessive stresses at equipment connections.

PART 3 - EXECUTION

A. Stock Requirements. The isolation manufacturer's representative must maintain an adequate stock of springs and isolators of type used so that changes made during construction and installation can be made.

B. Factory Representation. After installation, furnish factory-trained representative of the isolation manufacturer to check various isolators and report measured versus anticipated deflection on all isolators. Have the representative certify that isolators have been installed in accordance with manufacturer's recommendations and approved submittals.

END OF SECTION

SECTION 23 07 00
INSULATION - GENERAL

PART 1 - GENERAL

1.1 SCOPE

A. This section specifies the general requirements for furnishing and installing insulation. These requirements apply to all other Mechanical Division sections specifying insulation.

1.2 INTENT

A. The intent of insulation specifications is to obtain superior quality workmanship resulting in an installation which is absolutely satisfactory in both function and appearance. Provide insulation in strict accordance with the specifications for each type of service and apply as recommended by the manufacturer.

1.3 RELATED WORK

A. Division 09, Finishes. Painting and color coding.

B. Division 23, HVAC.

1. Air Handling Units. Internal insulation for air units is specified in the sections on air handling units. The units do not require external insulation.

2. Insulation. Refer to specific sections on individual insulation types.

1.4 APPROVALS

A. Submittals. Submit product data on each insulation type, adhesive, and finish to be used in the work. Make the submittal as specified in Division 01, General Requirements and obtain approval before beginning installation.

B. Sample Application. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with the work.

1.5 FIRE HAZARD RATING

A. All duct and piping insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the Composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements.

PART 2 - EXECUTION

2.1 INSULATION

A. Insulate valves, fittings, flanges, and special items to the full thickness required for corresponding piping.

B. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also repair any damage caused by the condensation.

C. Do not insulate any piping until all pressure tests have been performed in accordance with specifications.

D. Where existing insulated piping, ductwork or other surfaces are tapped or damaged, remove existing insulation back to undamaged sections and replace with new insulation of the same type and thickness as existing insulation. Apply as specified for insulation of the same service.

END OF SECTION

SECTION 23 07 13
EXTERNAL DUCT INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides for the furnishing and installation of external insulation on low-velocity supply, return and outside air ducts, all VAV box hot water coil housings and tube bends, and all round low-velocity supply ductwork.

B. External insulation of concealed and exposed ducts is included in this section. Internal acoustic duct linings are specified under Ductwork and not included in this section.

C. External fire rated wrapping for ductwork is included in this section.

1.2 RELATED WORK

A. Division 23 - HVAC. Insulation - General.

PART 2 - PRODUCTS

2.1 INSULATION

A. Concealed Duct, Round, Flat Oval, or Rectangular. Insulation R-values shall comply with the current International Energy Conservation Code requirements. Provide flexible glass fiber insulation with factory-applied, reinforced Foil-Kraft vapor retarder facing. A minimum thermal resistance of 6.0 (sq.ft. x degrees F x hrs. per BTU) at 75°F is required, after installation (not in bag). Provide minimum 1-pound density insulation, which complies with ASTM C1290, C1136, C553.

B. Exposed Round and Flat Oval Duct. Provide flexible fiberglass insulation with glass cloth vapor barrier. A minimum thermal resistance of 6.0 (sq. ft. x degrees F x hrs. BTU) at 75°F is required.

C. Exposed Rectangular Duct. Provide rigid board duct insulation with minimum R = 6.0. A minimum density of three pounds per cubic foot and minimum 1 ½" thick insulation is required. Provide an integral, UL labeled, reinforced Foil-Kraft facing on the outside surface.

D. Standing Seams. Insulate standing seams and stiffeners that protrude through the insulation with 0.6-pound-per-cubic-foot density, 1 ½ inch thick, unfaced, flexible blanket insulation. As a vapor seal, use 8-ounce canvas with vapor barrier coating. Insulation should not prevent adjustment of damper operators.

2.2 COATING AND ADHESIVE

A. Coating. Provide Foster 30-65 or Childers CP-34 vapor barrier coating.

B. Adhesive. Provide Foster 85-60 or Childers CP-127 vapor barrier adhesive.

PART 3 - EXECUTION

3.1 FIRE SAFETY REQUIREMENTS

A. Do not extend duct coverings through walls or floors required to be firestopped or required to have a fire resistance rating. Interrupt duct coverings in the immediate vicinity of heat sources, such as electric resistance or fuel-burning heaters.

3.2 CONCEALED DUCT, ROUND, FLAT OVAL OR RECTANGULAR

A. Insulation shall be wrapped tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches. In addition, secure insulation to the bottom of rectangular ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center.

B. On circumferential joints, the 2-inch flange on the facing shall be stapled with 9/16-inch flare-door staples on 6-inch centers, and taped with a minimum 3-inch-wide strip of glass fabric and coating, or a 3-inch-wide strip of 8-ounce canvas adhered with adhesive. Cover all seams, joints, pin penetrations and other breaks with coating reinforced with glass fabric.

C. On circumferential joints, the 2-inch flange on the facing shall be stapled with 9/16-inch flare-door staples on 6-inch centers, and taped with a minimum 3-inch-wide strip of glass fabric and coating, or a 3-inch-wide strip of 8-ounce canvas adhered with adhesive. Adhesive systems employing release paper will not be acceptable.

3.3 EXPOSED ROUND AND FLAT OVAL DUCT

A. Apply insulation to dry duct. Firmly butt all joints together. Seal longitudinal laps of factory-applied vapor barrier jacket with adhesive. Cover butt joints with a 3-inch-wide strip of factory-supplied vapor barrier jacket adhered with adhesive. Adhesive systems employing release paper will not be acceptable.

3.4 EXPOSED RECTANGULAR DUCT

A. Fill and point up all joints, perforations and exposed edges with coating reinforced with glass fabric or a 3-inch-wide strip of 8-ounce canvas adhered with adhesive. Securely fasten insulation to metal surface with adhesive and mechanical fasteners on 12-inch centers. Sheet metal screws and discs or other approved fasteners may be used.

3.5 INSTALLATION OF GREASE DUCT AND 1- AND 2-HOUR AIR DUCT WRAP

A. Installation to be per UL listing and manufacturer’s recommendations. When duct width or height is 18" or wider, use pins and clips on bottom of duct evenly spaced 8-to-12" apart from each other on all vertical duct sections, sides and bottoms. At overlaps, install pins and clips per manufacturer. Access doors to be installed with two metal access door plates, threaded studs welded around perimeter and sealed with CLK Firestop Sealant, three layers of Pyroscat FP Duct Wrap and 2-mil aluminum foil tape, all per manufacturer’s

recommendations. Floor and wall penetrations to be per manufacturer's recommendations. Repair damaged duct wrap, rod penetrations, etc., per manufacturer's recommendations.

3.6 RECTANGULAR DUCTWORK EXPOSED TO WEATHER

A. Insulate the ductwork with high density rigid insulation, 2" thick, minimum R = 8.0,with sloped top (minimum ½" per foot) coated with continuous glass fab, Foster exterior mastic similar to Selfas GPM 35-00 or Childers CP-10/11, white, with final covering of 0.024-inch thick aluminum jacketing, with seams on bottom of duct, and all joints sealed weathertight per manufacturer's recommendations. Aluminum jacketing to be self-fastening, Type 3003-H14 aluminum alloy.

END OF SECTION

SECTION 23 07 19.01
LOW-TEMPERATURE PIPING INSULATION

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for installing and furnishing low temperature piping insulation of Fiberglass, Armaflex AP or Koolphen-K or as noted below. The insulation will be used for low temperature application including chilled water, refrigerant, domestic cold water, horizontal roof drain and emergency overflow piping and related drain bodies, condensate drains, and horizontal portions of waste lines above grade that receive condensate from air handling units or evaporators.

1.2 RELATED WORK

A. Division 23, HVAC. Insulation - General.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

Use one of the following as noted in the schedule below:

A. Fiberglass premolded pipe insulation, 4 PCF density, k-value 0.23 btu· in/hr· ft^2· °F at 75 °F, R-value = 4.3/inch, with factory-applied reinforced All Service Jacket having integral laminated aluminum vapor barrier.

B. Armaflex AP flexible closed cell elastomeric pipe insulation, 4 PCF density, k-value 0.27 btu· in/hr· ft^2· °F.

C. Premolded Phenolic Foam, closed cell pipe insulation, 2.5 PCF density, k-value 0.13 btu· in/hr· ft^2· °F at 75 °F, R-value = 7.6/inch, with factory-applied reinforced All Service Jacket having integral laminated aluminum vapor barrier. Koolphen-K, Insul-phen by Resol Co. or equal. Insulation shall be free of all CFC or HCFC. Material to comply with ASTM C1126 Type II and III grade 1, and comply with 25/50 flame smoke spread.

All above materials shall have Flame spread/Smoke developed rating less than 25/50 in accordance with ASTM E 84.

All materials to be installed and vapor sealed in accordance with the manufacturer's recommendations.

	Thickness (Inches)		
Insulated Unit	Fiberglass	Koolphen-K	Armaflex AP
Refrigerant Suction Piping	—	—	1 (1)
(1) Pipe 1-1/2" and less - 1" insulation; larger than 1-1/2" - 1-1/2" insulation			

2.2 FLANGE, VALVE AND FITTING INSULATION

A. Provide molded or mitered covers for flanges, valves and fittings. Refer to paragraph 3.2 for method of fabrication.

2.3 INSULATION SHIELD

A. Field Fabricated. Use sections of high density Koolphen-K, fiberglass, or foamglass insulation that will support the bearing area at hangers and supports. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 4 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below.

Adhere metal shield to insulation so that metal will not slide with respect to insulation.

Pipe Diameter	Insulated Section Length in Inches	Minimum U.S. Standard Gauge of Metal Shield
3" and smaller	12	18
4" to 6"	12	16
8" to 18"	18	14
18" and larger	24	12

2.4 SEALANT, ADHESIVE AND FINISH

A. Sealant. Foster 95-44 or Childers CP-76 to be used at valve covers and vapor stops.

B. Adhesive. Furnish Foster 85-60 or Childers CP-127 to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers. Self-sealing laps and butt strips are not allowed.

C. Finish. Use Foster 30-65 or Childers CP-34 with glass fabric reinforcement.

D. Finish Armaflex AP insulation installed outdoors with minimum two coats of Armstrong Finish per manufacturer's recommendations.

2.5 ALUMINUM JACKETING

A. Apply aluminum jacketing to all fiberglass and Phenolic insulated pipe located outdoors or as noted. For piping in crawl spaces, apply white PVC sealed jacketing.

1. Piping. Furnish for finishing insulated pipe, a self-fastening jacket of type 3003-H14 aluminum alloy, 0.016-inch thick.

2. Valves, Fittings and Flanges. For finishing all valves, fittings and flanges, and smaller installations, provide formed aluminum covers, 0.024-inches thick, Type 3003-H14 aluminum alloy.

3. Straps and seals. Provide aluminum strapping seals for jackets and covers according to manufacturer's recommendations.

4. Acceptable manufacturers. Jacketing as manufactured by Preformed Metal Products Company, Childers or Johns-Manville will be acceptable.

PART 3 - EXECUTION

3.1 PIPE

A. Apply insulation to clean, dry pipes. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with adhesive.

B. Where piping is interrupted by fittings, flanges, valves or hangers and at intervals not to exceed 25 feet on straight runs, an isolating seal (vapor stop) shall be formed between the vapor barrier jacket and the bare pipe by liberal application of the sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to and along 2 inches of the jacket. This shall be provided only for chilled water service. In areas with high ambient temperature and humidity conditions, seal all butt joints with vapor stop sealant in accordance with recommendations of the insulation manufacturer.

3.2 VALVES, FLANGES AND FITTINGS

A. Insulate all valves, flanges and fittings with factory molded or mitered fitting covers secured with wire. Thickness of insulation shall be equal to that of adjoining piping. Mitered covers for pipe 2" and smaller shall be minimum 3-piece to the side, and pipe 2-1/2" and larger shall be minimum 6 pieces to the side. The fitting shall then be rasped or otherwise formed to have a smooth appearance.

B. Finish with 1/4-inch layer of Foster 30-65 or Childers CP-34 reinforced with glass fabric.

3.3 CONTROL VALVE COVERS

A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.

B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with glass cloth and two coats of finish.

3.4 SHIELDS AND HANGERS

A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.

END OF SECTION

SECTION 23 08 00
AIR BALANCE

PART 1 - GENERAL

1.1 SCOPE

This section covers final air balance operations after construction of the air system.

A. Testing Agency. The contractor shall secure the services of an independent air balance and testing agency to perform complete balance, adjustment and testing of air moving equipment and air distribution systems, including terminal units. Agency shall have on its staff at least one certified member of NEBB or AABC, who has been a member in good standing for at least 3 years, and the balancing agency shall be NEBB or AABC certified for a period of at least three years. Approved firms to provide this work are PHI Service Agency, Engineered Air Balance.

B. Equipment. Instruments used shall be accurately calibrated and maintained in good working condition. Equipment shall be as listed by the Associated Air Balance Council or NEBB for this type work.

C. The items requiring testing, adjusting and balancing include the following:

AIR SYSTEMS:
Supply Fan AHU
Zone branch ducts
VAV systems
Diffusers, Registers and Grilles
Coils (Air Temperatures)

D. The balancing contractor shall provide tests to demonstrate the specified capacities and operation of all equipment and materials comprising the systems. Such tests other than as described herein, which are deemed necessary by the Engineer to indicate the fulfillment of the contract, shall be made. The Balancing (HVAC) Contractor shall then make available to the Engineer such instruments and technicians as are required for spot checks of the system.

E. The drawings and specifications indicate valves, dampers, sheaves and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Mechanical Subcontractor to install these devices in a manner that will leave them accessible and readily adjustable. The Balancing (HVAC) Contractor may be consulted if there is a questionable arrangement of a control or adjustable device.

F. The balancing contractor shall be responsible for inspecting, balancing, adjusting, testing and logging the data of the performance of fans, all dampers in the duct systems, and all air distribution devices. The General Contractor, the Mechanical Subcontractor and the suppliers of the equipment installed shall all cooperate with the Balancing (HVAC) Contractor to provide all necessary equipment cutsheets.

G. The Balancing (HVAC) Contractor shall provide the following services:

1. During construction, inspect the installation of refrigerant piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems. The inspection of the work will cover that part relating to proper arrangement and adequate provisions for the testing and balancing. The inspections shall be performed periodically as the work progresses. A minimum of three inspections are required as follows:

   (a) When new roof top unit, condensing units, air handlers, mini-splits, and packaged terminal unit are installed.

   (b) When 60% of the VAVs and air terminals are installed.

   (c) When 90% of the VAVs and air terminals are installed.

2. Submit brief written report of each inspection to A/E, with copies to Contractor, Mechanical Engineer, Inspector, and Owner's Representative.

3. Upon completion of the installation and start-up of the mechanical equipment by the Mechanical Subcontractor, the Balancing (HVAC) Contractor will balance, test and adjust the systemic components to obtain optimum conditions in each conditioned space in the building. If construction deficiencies are encountered which preclude obtaining optimum conditions, and the deficiencies cannot be corrected by the Contractor within a reasonable period of time, cease TAB services and advise the Architect in writing with an information copy to the Owner's Representative. The Balancing (HVAC) Contractor is advised that deficiencies in HVAC construction are often encountered during final TAB services and he should include in his bid an amount he deems advisable to compensate for his time in identifying the deficiencies to the Mechanical Contractor and awaiting their correction.

4. Fourteen (14) days, or earlier, prior to the Owner's Final Inspection, as requested by the General Contractor, the TAB shall prepare seven (7) copies of the completed Balancing (HVAC) Test and Balance Report. The Report shall be complete with logs, data, and records as required herein and all logs, data, and records shall be typed, produced on white bond paper, and bound with plastic spiral. The Reports shall be certified accurate and complete by a principal Engineer of the Balancing (HVAC) Contractor. Transmit one (1) copy direct to the Owner's Representative and the remaining six (6) copies to the Architect. The Architect will, in coordination with the Engineer, review the report. Upon approval, two (2) copies will be submitted to the Owner's Representative and two (2) copies transmitted to the Contractor.

5. The Report shall contain the following general data in a format selected by the TAB Agency for clarity and ease of reference.

   Project No.
   Contract No.
   Project Title:
   Project Location:

Project Mechanical Engineer: (Name)
TAB Field Test Engineer: (Name)
TAB Testing Diagnosis and Analysis by : (Name)
TAB Agency: (Firm name and address)
Mechanical Subcontractor: (Name and address)
General Contractor: (Name and address)
Inclusive dates tests were performed and date of Report
Test Certification Number:
Certification by principal engineer
The TAB Report shall normally contain the following sections:
Table of Contents
General data and certification
Brief Description of Tests and Test Procedures (including instruments used)
Summary of Test Results (note deficiencies, if any, and action taken for correction)
Logs, Data, and Records

H. REPORTS

1. Final TAB Report - The TAB agency shall submit the final TAB report for review by the engineer. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards or NEBB procedures.

1.2 RELATED WORK

A. Division 23 - Mechanical.

1. Ductwork.

2. Fans.

3. Air Devices.

1.3 PROCEDURES

A. Operating Tests. After all mechanical systems have been completed, and prior to air balance, subject each system to an operating test under design conditions to ensure proper sequence of operation in all operating modes. Make adjustments as required to ensure proper functioning of all systems.

B. Certified Data. The contractor shall provide the balance and testing agency the certified data on fans, grilles, coils, filters and other equipment required for proper balancing of the system.

C. Adjustment. The balance and testing agency shall provide necessary adjustments to air flow dampers, fans, sheaves, extractors, splitters, and other controls as required to properly balance the system. TAB firm to include in his bid, all belts and sheaves, and labor to replace and adjust all sheaves to obtain scheduled air flow.

D. Balancing. The balance agency shall follow balancing and testing procedures published by the Associated Air Balance Council, or NEBB.

E. Reports. Compile the test data on report forms as listed in the AABC "National Standards for Total System Balance". Include data on air volume at supply and return grilles and diffusers. Include exhaust air volume. Contractor's forms are not acceptable unless all data included is in the latest "National Standards" by AABC.

F. The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards. Adjustment tolerances shall be + or - 10% unless otherwise stated.

G. Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levels, and similar controls and devices shall be marked to show final settings.

PART 2 - EXECUTION

2.1 AIR AND WATER BALANCE (BY AIR BALANCE AGENCY)

A. General Requirements.

1. Do all work required for complete testing and adjusting of all HVAC systems.

2. Provide all instruments and equipment required to accomplish necessary testing, adjusting, and as required by the engineer to verify performance. All instruments shall be in accurate calibration and shall be calibrated in ranges that will be expected.

3. Prior to final observation, submit to the owner a letter certifying:

(a) That all balancing is complete.

(b) That all controls are calibrated and functioning properly.

(c) That all parts of the various systems are complete and ready to be turned over to the owner for continuous operation. Submit with letter a report tabulating data requested by the Engineer.

B. Design Conditions. The HVAC systems have been designed to maintain the inside conditions indicated below when operating with the outside conditions stated. Install, test and adjust the systems so that they will produce the inside conditions for design; however, contractor must be prepared to provide a suitable test to prove that equipment is producing capacities scheduled.

1. Inside Conditions.

Summer: 75 F.D.B. 50% R.H.
Winter: 72 F.D.B.

2. Outside Conditions.

   Summer: 98 F.D.B. 78 F.W.B.
   Winter: 20 F.D.B.

C. Adjust all air system dampers and volume controllers to obtain proper air balance throughout the conditioned area. The air quantities shown on the drawings for individual outlets may be changed to obtain uniform temperature within each zone, but the total air quantity shown for each zone must be obtained. Maximum temperature variation within a zone to be 2°F.

D. Adjust all blower drives to obtain proper total amounts of air. Change drive if necessary to accomplish proper air flow. Costs for drive changes, including belts and sheaves will be borne by the TAB contractor.

E. Adjust all valves in the various water systems to obtain proper amount of water to each piece of equipment.

F. Calibrate, set and adjust all automatic temperature controls. Check proper amount of water to each piece of equipment.

G. AIR SYSTEMS

The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards:

1. For supply fans:

   (a) Fan speeds - test and adjust fan RPM to achieve maximum or design cfm.

   (b) Current and voltage - test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not at or above the service factor.

   (c) Pitot-Tube traverse - perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total cfm.

   (d) Outside air - test and adjust the outside air on applicable equipment using a pitot-traverse. If a traverse is not practical use the mixed air temperature method if the inside and outside temperature difference is at least 20 degrees Fahrenheit or use the difference between pitot-tube traverses of the supply and return air ducts.

   (e) Static pressure - test and record system static profile of each supply fan.

2. For zone, branch and main ducts:

(a) Adjust ducts to within design cfm requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

3. For VAV systems:

(a) Set volume regulators on all terminal boxes to meet design maximum and minimum cfm requirements.

(b) Identification - identify the type, location, and size of each terminal box. This information shall be recorded on terminal box data sheets.

4. For diffusers, registers and grilles:

(a) Tolerances - test, adjust and balance each diffuser, grille, and register to within 10% of design requirements. Minimize drafts.

(b) Identification - identify the type, location and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

5. For coils:

(a) Air temperature - once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry bulb temperature shall be taken on the entering and leaving side of each heating coil.

H. DUCT LEAKAGE TESTING. The installing contractor shall isolate and seal sections of ductwork for testing. The test pressures required and the amount of duct to be tested shall be described by the engineer in the appropriate duct classification section. All testing shall be based on one test per section only unless otherwise noted.

I. VERIFICATION OF HVAC CONTROLS. The TAB agency shall be assisted by the building control systems contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.

2. Verify that all controlling instruments are calibrated and set for design operating conditions.

J. TEMPERATURE TESTING. To verify system control and operation, a series of three temperature tests shall be taken at approximately two-hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees Fahrenheit from the thermostat or control setpoint during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

K. TAB REPORT VERIFICATION. At the time of final inspection, the TAB agency may be required to recheck, in the presence of the Owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

L. BUILDING/ZONE PRESSURIZATION. The TAB agency shall test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differential. For positive pressure areas, it shall set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, it shall set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

1. After balancing is complete and before calling for final observation, record, and submit for record reports as noted herein and per recommendations of AABC or NEBB.

2. For each air unit:

   (a) Suction and discharge static pressure, and total static.

   (b) Fan rpm, measured by tachometer; verify rotation.

   (c) Motor nameplate F.L.A., actual amps, voltage.

   (d) Measured cfm for total supply, return and outside air.

   (e) Entering and leaving air temperature for each coil.

3. Each condenser unit:

   (a) Ambient air temperature, condenser discharge temperature.

   (b) Motor nameplate F.L.A., actual amp, voltage.

   (c) Suction and discharge pressures, temperature.

4. Other reports and forms to be completed and submitted. Provide instrument list, air moving test sheet, exhaust fan data sheet, static pressure profile, return air/outside air data, fan and motor pulley sheets, duct traverse readings, duct traverse zone totals, air monitoring station data, air distribution test sheet, terminal unit test sheets, air-cooled condenser test sheets, cooling coil data, heating coil data, flow measuring station data, duct leak test sheets. All forms shall be as listed in the latest "National Standards for Total System Balance", or shall be similar, but must note the same information.

M. After Owner Occupancy. After owner has occupied and is using the building, make three additional inspections of the system (at 1 month intervals) to:

1. Correct any owner observed temperature imbalances.

2. Check correct operation of equipment and verify by letter to the engineer on each trip. List in the letter corrections made.

N. At Time of Job Completion.

1. Provide such tools, equipment and personnel as required to conduct tests and demonstrate the acceptability of the various systems.

2. Have the authorized representatives of the various manufacturers available if requested.

END OF SECTION

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Control Equipment

B. Software

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION:

A. Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gauge taps, flow meters.

B. Ductwork Accessories: Installation of automatic dampers, smoke detectors. Connection of damper end switches.

1.3 REFERENCES

A. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.

B. ASME MC85.1 - Terminology for Automatic Control.

C. NEMA EMCa - Energy Management Systems Definitions.

1.4 DEFINITIONS

A. Ensure terminology used in submittals conforms to ASHRAE 85.

1.5 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

B. Central and remote hardware, software, and interconnecting wire and conduit.

C. Terminal unit controls for coils, fan coils.

D. Damper Motors and Valve Operators: Electronic

1.6 SUBMITTALS

The submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of the specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed

system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the specified system performance.

A. Shop Drawings:

1. Trunk cable schematic showing programmable control unit locations, and trunk data conductors.

2. List of connected data points, including connected control unit and input device.

3. System graphics indicating monitored systems, data point addresses (connected and calculated), and operator notations.

4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

5. Descriptive data and sequence of operation for operating, user, and application software.

6. Flow diagram(s) showing all equipment and controls in the system.

7. Electric ladder diagram(s), connection diagram(s), and electronic connection diagram(s), each as applicable.

8. Control sequence(s) designating each control device in the system, including DDC system control strategies.

9. Material lists(s) covering each device coded to match flow and connection diagrams. Field and panel located hardware shall be identified.

10. A DDC system points list and input/output summary.

11. Detailed resumes of all designers, programmers, installers, and service personnel assigned to the project. Once approved, these personnel shall be active in their respective capacities throughout the project, and work shall be performed strictly by only these individuals.

12. Material and equipment lists including manufacturer, model number, diagram device designation and a clearly identified product data sheet with applicable portions highlighted.

13. Upon completion of the work, The Controls Manufacturer/Contractor shall provide the Owner with “record” layouts of the system. Layouts shall indicate all equipment and the function of each item shall be indicated.

14. Operating instructions and as-built system flow diagrams and other complete controls drawings shall be prepared, bound, and mounted in a frame or cabinet in

mechanical equipment room. Each relay, transducer, switch, motor, controller, indicator (when inside panel) other control system device, and item of equipment, etc., shall be identified with a number or mark identical to one which shall be tagged on each item. Large items of equipment may be identified by a suitable symbol listed in a legend on the control diagram. Drawings/operating instructions shall be reduced to an 11" x 17" format for placement in the mechanical room, (or may be prepared in that format initially).

15. Provide a minimum of four(4) copies of an owning, operating and service manual covering the entire system, as described below:

    (a) Each O & M manual shall be organized into systems and shall contain the manufacturer's complete, detailed operating and maintenance instructions with equipment data for each piece of installed material and equipment under this contract.

    (b) Each manual shall be composed of 8-1/2" x 11" instruction sheets with full size (not less than 11" x 17") drawing sheets folded in and having a reinforced margin. Data shall clearly indicate information for specific material or equipment installed with extraneous material crossed out or removed.

    (c) The O & M manual shall include, but not be limited to, the following information.

        (1) As-built system layouts showing equipment, conduit routing, controls, test ports, terminals, sizes and locations. Indicate component piece or identify as tagged on layouts.

        (2) As-built wiring and control diagrams to include schematics with data and narratives to explain the detailed operation and control of each component.

        (3) Control schedules of all control components providing data for proper system operation and performance of maintenance.

        (4) A control sequence describing start up, operation and shut down.

        (5) A complete list (hard copy) of all controls programs and a flow chart of the entire controls program.

        (6) Operating and maintenance instructions for each piece of equipment, including trouble shooting, check lists, repair and adjustment.

        (7) Manufacturer's bulletins, data sheets, descriptive data and serial number, wiring diagrams and control schematics for equipment with self contained controls which are interfaced to the

temperature control system (such as smoke detectors, fire alarm panels (circuits which may disable air handling unit fans) etc.)

(8) Parts lists and recommended spare parts with complete detailed ordering information correlated to tagged identification on system layouts.

(9) Safety instructions.

B. Product Data: Provide data for each system component and software module.

C. Manufacturer's Installation Instructions: Include for all manufactured components.

1.7 PROJECT RECORD DOCUMENTS:

A. Accurately record actual location of control components, including panels, thermostats, and sensors.

B. Revise shop drawings to reflect actual installation and operating sequences.

C. Include data specified in "Submittals" in final "Record Documents" form.

1.8 PROJECT RECORD DOCUMENTS:

A. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.

B. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

C. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.9 QUALIFICATIONS:

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

B. Installer: Company specializing in applying the work of this Section with minimum three years documented experience.

C. Design system software under direct supervision of a person experienced in design of this work.

1.10 COORDINATION:

A. Ensure installation of components is complementary to installation of similar components in other systems.

B. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

C. Ensure system is completed and commissioned.

D. It shall be the responsibility of the Controls Manufacturer/Contractor to verify, prior to bid, that sequences of operation and control approaches presented within the drawings and these specifications are appropriate for the HVAC systems to be used, and that the systems provided are complete.

E. The Controls Contractor or Subcontractor shall coordinate design and installation of the controls system with the fire alarm system.

F. The Controls Contractor or Subcontractor shall coordinate bidding and execution of the work with that of other trades, including mechanical (ducting), testing, adjusting, and balancing (reference also Part 3 below), and electrical (including fire alarm). Full cooperation and coordination with the other trades shall be required. The controls contractor/subcontractor shall be responsible for verifying proper installation (to be done by mechanical trades) of all wells, ports, etc. needed for installation of all control and instrumentation devices.

G. It shall be the joint responsibility of the Mechanical Contractor and the Controls Subcontractor to verify, prior to bid, that the applicable equipment manufacturer(s) approve the method of controls to be used with the particular equipment and system. Bring any questions to the Engineer's attention.

1.11 WARRANTY:

A. Warranty: Include coverage for field programmable micro-processor based units. The parts, service and labor will be warranted for 2 years from acceptance date. Acceptance date starts 45 days after project final acceptance, provided the controls have operated without failure during the 45-day period. If a controls failure occurs during the 45-day period (or successive one) the date for controls final acceptance resets to the date when the controls system is fully/properly operational. The reset process shall perpetuate until the system properly operates without failure for 45 consecutive days.

1.12 MAINTENANCE SERVICE:

A. Furnish service and maintenance of energy management and control systems for one year.

B. Provide four complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

1.13 EXTRA MATERIALS:

A. Provide one of each type of exposed sensor.

1.14 PROTECTION OF SOFTWARE RIGHTS:

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.

2. Limiting copying

3. Preserving confidentiality.

4. Prohibiting transfer to a third party.

1.15 SCOPE

A. Furnish and install a complete working controls system of Direct Digital Controls (DDC), including any and all instrumentation necessary for a complete automatic control system as indicated by the drawings and as specified herein. System shall be designed and installed so as to obtain all functions and results necessary or appropriate for the system(s), and as hereinafter specified.

B. The automatic temperature control system shall be a microprocessor based, Direct Digital Control, System utilizing a combination of electric/electronic components, as indicated.

C. Provide control and interlock wiring necessary to accomplish sequences, automation and interlocks specified in this Section. This includes but is not limited to 120 volt and low voltage wiring. Materials and installation are specified in Division 26 requirements.

D. Work to be provided includes, but is not necessarily limited to:

1. Engineering/design

2. Submittals

3. DDC, electronic, and electric hardware

4. Controls panels

5. DDC data base/programming

6. Installation (including all related electrical wiring, ports, wells, etc.)

7. Start up and calibration

8. System commissioning/testing, including report certifying completed testing and commissioning and proper operation.

9. Spot checks for system operation, as directed by Engineer.

10. Owner instruction

11. Operating manuals.

12. Warranty replacement and service

E. All electrical work associated with this system shall be performed under this section of these specifications, (including any related 120V electrical work not indicated by drawings that may require connections at panelboard spares and/or spaces and related distribution to and for the controls system).

F. It shall be the responsibility of the Division 23 Contractor to ensure all controls work is properly coordinated.

G. Control systems to be provided include, but are not necessarily limited to, the following systems.

1. Building automation/energy management/temperature controls for unitary equipment.

2. Additional control systems and components as indicated by the drawings, as specified herein, or as necessary to accomplish the work described.

1.16 RELATED WORK:

A. Motor starters, switches, outlet boxes and other material and devices necessary to accomplish power wiring and not specified in the Section are specified in Division 26. requirements.

1.17 SUMMARY OF WORK:

A. Contractor shall achieve specified sequences by replacing the existing Trane controls system with the most up to date direct digital central processor available that will interface and be compatible with the existing peripheral devices. It shall be within the contractor's scope of work to reconnect the existing peripheral devices to the new central processor and ensure that each device functions correctly. The controls contractor shall verify the operation of those components of the existing system that will be incorporated into the new system and document all deficiencies. This shall be completed prior to beginning installation of the new DDC components. It shall be at the Owner's discretion as to when repairs are made and who makes them. Any deficiencies located after this report is submitted will be repaired/corrected by the DDC contractor at no cost to the Owner. Additional peripheral devices including but not limited to Local Control Units (LCU), input/output (I/O) devices, I/O interfaces, housings, interconnect cables, software and end devices (sensor, actuators, dampers, valves and relays) that are required to achieve the specified sequences for the added equipment/functions that are part of this contract shall be included.

B. It is the DDC contractor's responsibility to provide the Owner with a completely functional total system, meaning the new components will function with the existing components and be completely compatible and provide the specified sequences. Any upgrades of the existing

components that need to be made to achieve this compatibility and provide these functions are the control contractor's responsibility.

C. The parts, service and labor will be warranted for 2 years from acceptance date. Acceptance date starts 45 days after project final acceptance, provided the controls have operated without failure during the 45-day period. If a controls failure occurs during the 45-day period (or successive one) the date for controls final acceptance resets to the date when the controls system is fully/properly operational. The reset process shall perpetuate until the system properly operates without failure for 45 consecutive days.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Seimesn, Johnson, Carrier

2.2 TIME CONTROLS:

A. Time control for starting and stopping of air conditioning equipment, as described in control sequence, shall be by DDC control.

1. Status Indicators: Provide differential pressure switches to indicate status of all fans.

2.3 STAND ALONE DDC PANELS:

A. General: Stand alone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each stand alone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. Sufficient number of controllers shall be supplied to fully meet the requirements of these Specifications and the attached point list.

B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:

- Control processes
- Energy Management Applications
- Alarm Management
- Historical/Trend Data for all points
- Maintenance Support Applications
- Custom Processes
- Operator I/O
- Dial-Up Communications from at least one panel
- Manual Override Monitoring

C. Point types: Each DDC panel shall support the following types of point inputs and outputs:

- Digital Inputs for status/alarm contacts

- Digital Outputs for on/off equipment control
- Analog Inputs for temperature, pressure, humidity, flow, and position measurements
- Analog Outputs for valve, damper or other actuator position control, and capacity control of primary equipment
- Pulse Inputs for pulsed contact monitoring
- Tristate outputs for equipment control
- All analog inputs and outputs will be 0-10 VDC, or 4-20 mA

D. Expandability: System shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.

E. System architecture shall support 10% aggregate expansion capacity of all types of DDC panels, and all point types (i.e., include spare I/O modules to accommodate 10% expansion) included in the initial installation. 10% spare capacity shall be provided in each panel.

F. Serial Communication Ports: Stand alone DDC panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC work stations, and panel mounted or portable DDC panel Operator's Terminals. Stand alone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printer, or network terminals. Provide one (1) portable operators terminal.

G. Hardware Override Switches: Operator shall have the ability to manually override automatic or centrally executed commands at DDC panel via local, point discrete, onboard operator override switches for binary control points and gradual switches for analog control type points.

H. Override Monitoring: DDC panels shall monitor status or position of software and hardware overrides, and include this information in logs and summaries to inform operator that automatic control has been inhibited. DDC panels shall also have the capability to collect override activity information for daily and monthly reports.

I. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

J. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device. One DDC panel shall act as a master time keeper and a second panel shall act as a sub master.

K. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all stand alone DDC panels to prevent the loss of database or operating system

software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

L. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port, or via telephone line dial-in.

2.4 SYSTEM SOFTWARE FEATURES:

A. General:

1. All necessary software to form a complete operating system as described in these Specifications shall be provided, installed, tested and demonstrated.

2. The software programs specified in this Section shall be provided, installed and tested as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:

1. Pre-Tested Control Algorithms: DDC panels shall have the ability to perform the following control algorithms:

(a) Two Position Control

(b) Proportional Control

(c) Proportional plus Integral Control

(d) Proportional, Integral, plus Derivative Control

(e) Automatic Control Loop Tuning is desirable, but shall be easily disengaged

2. Equipment Cycling Protection: Control software shall include a passive provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. Heavy Equipment Delays: System shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

4. Set Points: All set points shall be variable set points.

5. Powerfail Motor Restart: Upon resumption of normal power, DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

2.5 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS:

A. Each Stand Alone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

B. Each ASC shall operate as a stand alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

C. Each ASC shall have sufficient memory to support is own operating system and data bases including:

- Control Processes
- Energy Management Applications

D. The operator interface to any ASC point data or programs shall be through a portable operator's terminal connected to any DDC panel in the network.

E. Powerfail Protection: All system setpoints, proportional bands, control algorithms, and their programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

F. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:

1. Start-up or shutdown selected equipment

2. Adjust setpoints

3. Add/Modify/Delete time programming

4. Enable/Disable process execution

5. Lock/Unlock alarm reporting for each point

6. Enable/Disable Totalization for each point

7. Enable/Disable Trending for each point

8. Override PID Loop setpoints

9. Enter temporary override schedules

10. Define Holiday Schedules

11. Change time/date

12. Enter/Modify analog alarm limits

13. Enter/Modify analog warning limits

14. View limits

15. Enable/Disable Demand Limiting for each meter

16. Enable/Disable Duty Cycle for each load

17. Add/Modify/Delete any input or output point

2.6 INTERLOCKS (Hardwired):

A. General: Provide switches, relays, PE switches, wire, conduit and other necessary devices (except motor starters and starter auxiliaries specified in Division 26 requirements and shown on E-series Drawings) necessary to accomplish interlocks specified, shown on Drawings, indicated in schedules, specified in other control sequences or required for proper functioning of various systems. Show such devices in the composite wiring diagram.

B. Air Handling Units and Exhaust Fans: Provide interlocks as indicated on Drawings, in schedules or specified in other sequences.

2.7 PROGRAMMING APPLICATION FEATURES:

A. Trend Point:

1. Sample up to six points, real or computed, with each point capable of collecting six samples at intervals specified in minutes, hours, days or months.

2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:

1. Allow definition of minimum of six messages, each having minimum length of twelve characters for each individual message.

2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.

3. Output assigned alarm with "message requiring acknowledgment".

4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:

1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.

2. Provide program times for each day of week, per point, with one minute resolution.

3. Automatically generate alarm output for points not responding to command.

4. Provide for holidays, minimum of 366 consecutive holidays.

5. Operator commands:

   (a) System logs and summaries

   (b) Start or stop point

   (c) Lock or unlock control or alarm input

   (d) Add, delete, or modify analog limits and differentials

   (e) Adjust point operating position

   (f) Change point operational mode

   (g) Open or close point

   (h) Enable/disable/ lock/unlock, or execute interlock sequence or computation profile

   (i) Begin or end point totalization. Modify totalization values and limits

   (j) Access or secure point

   (k) Begin or end HVAC or load control system.

   (l) Modify load parameter.

   (m) Modify demand limiting and duty cycle targets

6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:

1. Permit events to occur, based on changing condition of one or more associated master points.

2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.

3. Operator commands:

   (a) Define single master/multiple master interlock process.

   (b) Define logic interlock process.

   (c) Lock/unlock program.

   (d) Enable/disable interlock process.

   (e) Execute terminate interlock process

   (f) Request interlock type summary.

2.8 ADDITIONAL FEATURES:

A. Provide hardware for minimum 20 assignable/programmable points.

2.9 ELECTRICAL

A. General: All electrical wire, cable, fittings, connectors, conduit, 120V connections and distribution to panelboards, associated circuit breakers, and control devices, etc., associated with the systems under this Section of the specifications, including interlock wiring, shall be furnished and installed complete under this section of the specifications.

B. Separate Ground: DDC system/components shall employ and maintain a separate, "clean earth" grounding protection. "Mixing" of grounding systems shall be prohibited. (Isolate DDC controls conduits/metal boxes from other raceway systems using isolation bushings and other measures as necessary.)

C. Conduit: Except as noted below, **all** wire/cable (in walls, chases, mechanical rooms, above ceilings, etc.) Shall be run in conduit. Conduit types shall match those in Division 26 with regard to types (e.g. RGS, IMC, EMT) in particular spaces.

   Exception: Control wire/cable may be run outside conduit if all the following conditions prevail: located above accessible ceilings; plenum rated cable is used; less than 12 VAC or 12 VDC (nominal) is used; where allowed by all applicable administrative authorities; where labeled "controls" at not less than ten feet intervals; and where properly supported from structure, piping, or conduit - not from ceiling systems - at frequent intervals not exceeding five feet. Not to be used in detention facilities, higher education facilities, laboratories, health care facilities.

D. Color Codes and Labels: Control wires and cables shall be of consistent color codes and polarity throughout the project. Coordinate with Division 26 to provide unique color codes different than 208/120V, communications, etc., systems wherever possible.

All controls wire/cable and all conduit housing controls wire/cable shall be permanently labeled "CONTROLS" to distinguish it from power, lighting, data, communication, etc., system. Such labeling shall occur on not less than 10 foot intervals, and at least once in every room area and at all junction or pull boxes.

E. Provide all wiring to electric (120V, 24V) and electronic control devices.

F. Materials and installation shall be in accordance with the requirements of NFPA, the National electrical Code, and the electrical division (Division 26) of this specification. All electrical work included under this section shall be complete with labor, materials and installations.

G. Run all wiring and conduit concealed.

H. Where required for proper operation with electronic controls interfacing, provide relays and other devices with low impedance gold contacts.

I. Where required to maintain proper relay operation, increase minimum control wire gauges specified herein. Coordinate relay and voltage drop characteristics to ensure proper operation.

J. Minimum Wire Sizes: "Bus" wiring/cable - minimum 18 gauge shielded/twisted with protective jacket meeting 25/50 plenum requirements; 24V control "power" wiring to actuators and controllers - properly fused 16 gauge solid or stranded with THHN insulation; 120V wiring - 12 gauge solid with THHN insulation properly fused or protected by circuit breakers. Increase these minimum requirements if/as needed for the particular application.

Exceptions: Where manufacturer recommends in writing smaller size (higher gauge) cabling for the particular system/application, including considerations/provisions for all future system expansion/installation.

2.10 ELECTRIC ACTUATORS: DAMPERS, VALVES, AND TERMINAL BOXES

A. Damper operators shall be provided for each automatic damper and shall be of sufficient capacity to operate the damper under all conditions (including "drag" conditions for dampers).

B. Each operator shall be two-position type as required, indicated or specified, and shall be provided with spring-return for normally closed or normally open position for fire, freeze or moisture protection on power interruption as indicated.

C. Operators shall be suitable for installation in any orientation.

D. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.

E. All actuators having more than 100 lb.-in. torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator's output coupling with the

damper shaft. The self-centering clamp shall have a pair of opposed “V” shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.

F. All actuators having more than a 100 lb.-in. torque output shall accept a 1" diameter shaft directly, without the need for auxiliary adapters.

G. All actuators having more than 100 lb.-in. torque output shall have an all metal housing made from die-cast aluminum.

H. All actuators must provide overload protection throughout the full range of rotation, enabling the actuator to detect a blockage in the damper and withstand as continuous stall condition without premature failure, or degradation in performance.

I. All spring return actuators shall be capable of both clockwise or counterclockwise spring return fail-safe operation.

J. All spring return actuators shall use a continuously engaged mechanical return spring that returns the actuator to a fail-safe position within 15 seconds, under rated temperature and load, in response to a loss of power. Other fail-safe mechanisms that are either engaged only in response to a loss of power, or that are non-mechanical are not acceptable.

K. All actuators shall provide a means of manually positioning the output coupling in the absence of power.

L. Dual independently adjustable auxiliary switches must be integral to the actuator, thus maintaining a low total installed cost. The addition of this feature as an accessory kit is not acceptable.

M. All actuators having more than 100 lb.-in. torque shall provide a factory mounted electrical cable (3 feet) and conduit fitting, thus maintaining a low total installed cost.

N. All actuators shall not require more than 10 VA.

O. Proportional actuators shall accept a 0-10 VDC or 4-20mA control signal, and provide a 0-10 VDC feedback signal.

P. All actuators shall provide an easily readable high-contrast yellow on black position indicator.

Q. All actuators shall be designed for a minimum of 50,000 full stroke cycles at the actuator’s rated torque and temperatures, and manufactured using ISO9002 and ISO14000 registered procedures, and shall be UL873 and CSA22.2 listed. Actuators shall be as manufactured by SIEMENS.

2.11 TEMPERATURE SENSORS AND THERMOSTATS

A. Electronic Temperature Sensors/Transmitters

1. The electronic temperature sensors/transmitters shall be designed for wall service. Sensors shall be thermister type (consistent throughout system) and shall be supplied to match the related electronic controller.

2. Temperature sensors/transmitters shall, at a minimum, have the most stringent of the following characteristics: have an accuracy of not less than 0.4 degrees F over a range of 32 to 158 F. Sensor lead wire error shall not exceed 0.4 Degrees F. Submit tables showing the temperature ranges, accuracy, and the manufacturer's recommended lead wire length and gauge. Unless otherwise specified or needed by the application, single point sensors are to be used.

3. Sensors/transmitters shall provide a 4-20 ma, 0-10V, or 1-18V (nominal) proportional output, direct and/or reverse acting as required, and shall have the smallest degrees span appropriate for the particular application. Select 4-20, 0-10, or 1-18 to yield the least possible interference from other electric and inductive sources that the sensor or wiring/cabling may be near.

4. Provide a "divisioned" accessible dial at each space sensor which shall allow the zone occupant to adjust set point manually.. Provide dial with remote duct mounted sensor where indicated on drawings. Setpoints and allowable adjustments to be DDC System adjustable.

5. Provide a momentary override pushbutton (12 hour programmed override) at each space sensor. This override button shall provide a digital signal to the sensor's respective controller which may be used to provide after-hours (outside of time schedules) use of the controlled facility.

2.12 AIR SWITCHES AND TRANSMITTERS

A. Differential Pressure Air Flow Switches shall be mounted on the side of duct or equipment in a vertical position and have an adjustable differential pressure set point range of 0.05" + 0.02" to 12.0" + 0.1" W.C. (Contact shall be snap action type SPDT where for 120 vac.)

2.13 OTHER DEVICES/EQUIPMENT

A. Provide all other devices/equipment required to make the system function properly.

B. LOCAL CONTROL CABINET(S)

C. All electric/electronic peripherals and support devices (relays, controllers, transformer(s), power supply(ies), terminal blocks/strips, switches, alarms, etc.), shall be mounted in a control cabinet in the mechanical room. Cabinets shall be aluminum and graphite or all steel construction with full-fronted, hinged doors with locks.

2.14 LABELING

All instrumentation and controls shall be labeled with engraved laminate tags as to their identification with respect to the control record drawings and the equipment served. Set points after

testing, adjusting, and balancing shall also be labeled as per Part 4 of this section. All control wiring/cabling shall be labeled/tagged with numbered and descriptive ("text") adhesive bands prepared for that purpose. Refer also to Electrical Wiring above for labeling of controls conduits, junction pull boxes, and field wiring/cabling.

2.15 CO_2 / VOC SENSORS

A. CO_2 / VOC sensors to be Siemens QPA63 Series, operating on 24 Vac and provide 0-10 Vdc signal on CO_2 only or two 0-10 Vdc inputs (CO_2 and VOC) to the Ventilation Demand Calculator (AQP63.2), which will then combine the two signals to one output signal. Each signal can be adjusted in the field from the factory 50/50 setting. The AQP63.2 will also provide continuous calibration of the VOC signal. Permissable line lengths and wire sizes must be strictly adhered to. Provide sensors with LEDs, duct mounting kits, ventilation demand calculator.

PART 3 - **EXECUTION**

3.1 INSTALLATION:

A. Install in accordance with manufacturer's instructions.

B. Install electrical work in accordance with Division 26 Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

C. Provide with 120v AC, 15 amp dedicated power circuit to each programmable control unit.

3.2 MANUFACTURER'S FIELD SERVICES:

Prepare and start systems, commissioning, demonstration, instruction to the Owner (minimum 24 hours) by authorized factory-trained field engineer.

3.3 GENERAL

A. Install system and materials in accordance with manufacturer's instructions and rough-in drawings, and details on the drawings. Calibrate all components. Submit calibration reports.

B. Install electrical work and use electrical products complying with the requirements of the applicable Division 26 sections of these specifications. Mount controllers at convenient locations and heights.

C. All wiring, including motor control and interlock wiring associated with main control panel or local controls, and all conduit in connection with automatic temperature control system, shall be provided under this Section of the work.

D. Do not install conduit/wiring "beneath" insulation applied externally to ductwork and other surfaces.

E. Wiring shall be terminated by connecting to temperature control devices of numbered terminal strips as indicted on the drawings to be furnished by the temperature control manufacturer. All wiring shall be color coded and shall be tagged (numbered and text labeled) for future identification. (Tag describing wire/control purpose function, circuit/channel/terminal shall be provided. Numbered labels alone shall not be acceptable.)

F. Identify all transducers, switches, panels, controllers, sensors, actuators/dampers, etc., by means of engraved phenolic nameplates or other clear and permanent labeling acceptable to Engineer; embossed or punched plastic tape will not be acceptable.

G. Locate system control panel and all TCM's controllers, sensors, etc., where they can be calibrated and maintained from floor without use of a ladder. Avoid installation on any surface subject to vibration or condensation. Where installed on warm or cold surfaces (e.g. duct), install with specified insulation between the device and the surface to protect against condensation and temperature swings. Locate and install control dampers, etc., where they can be easily removed.

H. Install above-ceiling controllers, sensors, etc., where they are readily accessible without obstructions from other above-ceiling systems. Where needed, relocate such devices and provide necessary wiring/tubing extensions so that controller, device, etc., is readily accessible.

I. The Mechanical Contractor shall provide all openings (including duct access doors in ducts and equipment) required for thermostat bulbs and sensing elements in ductwork or mechanical equipment. Coordinate bidding and execution.

3.4 PROGRAMMING

A. Prior to completion of the controls installation, schedule time with Owner's designated representative(s) to evaluate and select programming options and requirements. Contractor shall provide designer/engineer for such meetings and consultations on an as-needed basis. Actual "in conference" time shall not exceed 4 hours. Preparation time for the conference shall be in addition to the "in conference" time, and shall be provided on an as-needed basis at the Contractor's cost.

B. At a MINIMUM, the following functions/features shall be programmed.

1. Sequences of operation

2. Automatic time scheduling

3. Self-adapting optimal start/stop, on an AHU by AHU basis

4. Night set-back/set-up, on zone by zone (and central plant) basis

5. Morning warm-up

6. Night cool down

7. Scanning and alarming (smoke/fire alarm shutdown, low temperatures, dirty filters, total run times, etc.)

8. Fine tuning and trend logging

9. All other programming required to meet control sequences and provide proper and satisfactory operation of the system.

3.5 COMPLETION AND TESTING

A. Contractor's Field Test: When installation of system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the Contractor.

1. Provide a detailed cross check of each sensor within the system by making a comparison between the reading and the sensor and a standard traceable to the National Bureau of Standards.

2. Provide a cross check of each control point within the system by making a comparison between the control command and the field controlled device.

3. Verify that all systems are operable from local controls in the specified failure mode upon system failure or loss of power.

4. Submit the results of functional and diagnostic tests and calibrations as a part of the request for substantial completion review.

B. Performance Test Report and Performance Certification

1. Verify and test program loading/unloading capability to the Owner's satisfaction.

2. After completion of the installation, adjust all thermostats, transmitters, sensors, motors, damper linkages and other equipment provided under this Contract. Place such items in complete operating condition and demonstrate that the controls are working satisfactorily.

3. Attend all test and balance functions (including Engineer's spot checks) and make adjustments, refinements, corrections, etc., in cooperation with the test and balance subcontractor. After testing and balancing, each control component shall have its setpoint clearly labeled on or adjacent to the component. (Neatly lettered pressure adhesive labels acceptable for this labeling only.)

   This testing and certification shall be provided prior to the Engineer's substantial completion review and punch list. Upon delivery of the report and certification, contractor shall schedule substantial completion review with Engineer. Coordinate also with Section 23 05 93 - Testing, Adjusting, and Balancing, for similar requirements regarding substantial completion.

4. Upon completion and thorough testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of the controls. Test report shall include contractor's signed statement certifying all testing indicated was performed and all systems are properly functioning.

C. Acceptance Testing: After complete installation, programming, and field testing, and submittal of described reports and certifications, contractor shall schedule substantial completion acceptance testing with the Engineer. Such testing shall be coordinated with Division 23 substantial completion "punch out" and air balance acceptance testing required by the contract documents. Verify and coordinate with other applicable Division 23 trades, as required.

1. Acceptance testing shall consist of various checks and spot checks for system calibration and functioning. Contractor shall provide all calibration equipment and other instrumentation necessary to conduct the tests, and shall provide system operator(s) and technician(s) to "exercise" and demonstrate various system features.

2. Should spot tests show system to be incomplete or operation/performance otherwise unsatisfactory, as determined by the Engineer, contractor shall perform remedial measures as required. Performance must be acceptable and as specified and programmed prior to certifying substantial completion.

3. Contractor shall provide compensation to Engineer based on standard hourly rates and reimbursable expenses for all time spent allotted to site visits/spot checks repeated after the first set (provided "repeat visits/tests" are due to contractor installation, incompleteness of or incorrect operation of system, equipment, substitutions, or other shortfalls in performance). Said compensation shall be deducted from contractor's payments due.

D. At completion of job, submit record drawings, including any changes made during construction. Place record drawings in suitable plastic sheet protector installed at system controller/control panel.

3.6 TRAINING

A. General: Provide combination of written and oral, classroom and field instruction to Owner's selected five personnel. Training shall be approximately 30 percent classroom and 70 percent field or hands-on.

B. Provide the services of competent instructors who will give full instruction to designated personnel in the operation, maintenance and programming of the system. Orient the training specifically to the system installed rather than a general training course. The instructors shall be thoroughly familiar with the subject matter they are to teach and the specific system(s) applications.

C. Provide a minimum of 20 hours of training as scheduled with the Owner. Provide a training manual for each student which describes in detail the data included in each training program. Provide equipment and material required for classroom training. Provide an additional 8 hours of training at the "next season change" or as otherwise requested by Owner.

Training on the functional operation of the specific system and controls shall include:

1. Operation of equipment
2. Programming
3. Diagnostics
4. Failure recovery procedures
5. Alarm formats (where applicable)
6. Maintenance and calibration

D. All training described above shall occur after the systems are fully operational so that hands-on training occurs specific to the Owner's particular systems. All training shall be complete and acceptable to the Engineer and Owner as a condition of final acceptance.

END OF SECTION

SECTION 23 21 13.02
PIPING AND PIPING APPURTENANCES FOR COLD WATER MAKE-UP AND EQUIPMENT DRAINS

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for furnishing and installing piping and piping appurtenances to drain air handlers and other equipment requiring drains, and for cold water makeup piping.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Valves, Strainers and Vents.

2. Pipe and Pipe Fittings.

3. Insulation.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Provide Schedule 40, galvanized steel pipe conforming to ASTM A 120, and galvanized class-150 malleable iron fittings.

2.2 PIPE AND FITTINGS

A. Provide seamless, hard-drawn, Type L, copper water tube conforming to ASTM B 88, and wrought copper fittings.

2.3 VALVES AND STRAINERS

A. For pressure-reducing and relief valves, provide Bell & Gossett dual unit No. D-250.

2.4 TRAPS

A. On each air handling unit condensate drain, provide a trap deep enough to overcome pressure of the unit.

PART 3 - EXECUTION

A. Install according to manufacturer's recommendations.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies the furnishing and installation of copper tubing, valves, strainers and sight glass for refrigerant piping.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Pipe and Pipe Fittings.

2. Valves, Strainers, and Vents.

3. Low Temperature Piping Insulation.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Furnish refrigerant piping of Type L-ACR, hard-drawn copper tubing with sweat-type, wrought copper fittings. Cast fittings are not permitted.

2.2 SERVICE VALVES

A. Provide angle or globe service valves, with sweat connections. Use packed-type valves with gasketed seal cap and back seat feature. Valves must be wrench operated. Furnish valves especially designed for refrigerant service, in conformance with the ARI code.

B. Place service valves at the inlet and outlet of each compressor, on both sides of each strainer and solenoid valve, and as otherwise shown and specified.

2.3 SIGHT GLASSES

A. Provide suitable double-window sight glass in the liquid line leaving the condenser.

2.4 SOLENOID VALVES

A. Furnish pilot-operated, floating piston solenoid valves suitable for operation with refrigerant.

B. Use valves with a bronze body and sweat-type connections.

C. Provide stainless steel stem and plunger assembly, and a stainless steel piston.

D. Furnish solenoid coils which are sealed and moisture proof.

E. Use electrical characteristics of 115-volt, 60 hertz.

PART 3 - EXECUTION

3.1 PRESSURE TEST

After all refrigerant equipment and piping are installed, charge the system with the proper refrigerant and dry nitrogen to 300 psig.

A. Test all joints with a Halide torch or an electronic leak detector.

B. Repair all leaks and retest each system until proved absolutely tight.

3.2 EVACUATION AND DRYING

After refrigerant system has been pressure tested, connect a suitable vacuum pump, and evacuate piping system, including all lines and equipment. Verify all equipment, gauges, hoses, hose gaskets, etc., are air tight and leak free. Using a calibrated micron gauge (Bacharach, J.B., Ronaire) triple evacuate refrigerant system as follows:

A. Evacuate refrigerant to 1500 microns, break vacuum using dry nitrogen. Do not allow any air to enter system.

B. Evacuate refrigerant system for the 2nd time to 1500 microns. Break vacuum using dry nitrogen. Do not allow any air to enter system.

C. Evacuate refrigerant system for the 3rd time to 500 microns. Maintain vacuum for a minimum of four hours at 500 microns.

D. Document all stages of evacuation and submit a brief written report to the Engineer.

E. Charge refrigerant system with the proper refrigerant. Do not allow any air or nitrogen to enter the system.

END OF SECTION

SECTION 23 30 00
DUCTWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides for furnishing and installing low , medium and high-pressure ductwork and includes duct construction and accessories.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Air Devices
2. Air Balance
3. Fans
4. Insulation
5. Emergency Generator Exhaust Piping, if required, is specified in drawing detail.

1.3 GUARANTEE

A. Guarantee all ductwork for one year from the date of final acceptance. The guarantee will cover workmanship, noise, chatter, whistling, or vibration. Ductwork must be free from pulsation under all conditions of operation.

1.4 CONTRACTOR COORDINATION

A. Erect all ducts in the general locations shown, but conform to all structural and finish conditions of the building. Before fabricating any ductwork, check the physical conditions at the job site and make all necessary changes in cross sections, offsets, and similar items, whether they are specifically indicated or not.

1.5 STANDARDS AND CODES

A. Except as otherwise indicated, sheet metal ductwork material and installation shall comply with the latest edition of the SMACNA HVAC Duct Construction Standards. Fiberglass ductwork material and installation shall comply with the latest edition of SMACNA Fibrous Glass Duct Construction Standards and NFPA Bulletin 90A. All air distribution devices (such as dampers) included in this specification shall comply with the latest applicable SMACNA manual and NFPA 90A.

PART 2 - PRODUCTS

2.1 DUCT MATERIAL

A. Except for the special ducts specified elsewhere, use prime galvanized steel sheets or coils up to 60 inches wide. Stencil each sheet with proper gauge and manufacturer's name. Stencil coils of sheet steel throughout on 10-foot centers with gauge and manufacturer's name. Contractor shall be cautioned that Engineer may random check duct and strap gauges with a micrometer to verify compliance with the specifications.

2.2 SEALING OF SEAMS AND JOINTS (LOW VOC)

A. The entire duct system shall be sealed. The seams and joints shall be sealed by use of low VOC Hardcast DT tape with FTA-20 (indoor) adhesive or low VOC RTA-50 adhesive for outdoor applications. Duct shall be thoroughly cleaned prior to application.

B. Provide Seal Class A to all transverse and longitudinal joints and all openings for all locations. Include additional sealing of TDF, duct-mate or other mechanical/gasketed joints. Spiral lock seams in round and flat oval duct need not be sealed.

2.3 LOW-PRESSURE DUCTWORK (LESS THAN 2 INCHES STATIC PRESSURE)

Low-pressure ductwork is defined as all exhaust ductwork downstream of fans and supply ductwork downstream of terminal units and fan-coil units.

A. Rectangular. Provide rectangular, low-pressure duct construction, gauges and reinforcing in accordance with the latest edition of the SMACNA HVAC Duct Construction Standards for 2" w.g. static pressure class (positive or negative), however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84".

Largest Dimension	U.S. Gauge
12" and less	No. 26
13" to 30"	No. 24
31" to 54"	No. 22
55" to 84"	No. 20
85" and above	No. 18

B. Round. Furnish round, low-pressure ducts which are spiral-wound, such as manufactured by United McGill Sheet Metal Company, or shop-fabricated round ducts with Pittsburgh lock longitudinal seams. Use the following minimum gauges for shop-fabricated spiral-wound ducts under positive pressure, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84".

Diameter	U.S. Gauge
26 " and less	No. 26
27 " to 36 "	No. 24
37 " to 50 "	No. 22
51 " to 60 "	No. 20
61" to 84"	No. 18

Use the following minimum gauges for shop-fabricated spiral-wound ducts under negative pressure, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84".

Diameter	U.S. Gauge
17" and less	No. 26
18" to 23"	No. 24
24" to 30"	No. 22
31" to 48"	No. 20
49" to 60"	No. 18
61" to 72"	No. 16

Use the following minimum gauges for shop-fabricated ducts with Pittsburgh lock longitudinal seams under positive pressure, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84".

Diameter	U.S. Gauge
14" and less	No. 26
15" to 26"	No. 24
27" to 36"	No. 22
37" to 50"	No. 20
51" to 60"	No. 18
61" to 84"	No. 16

Use the following minimum gauges for shop-fabricated ducts with Pittsburgh lock longitudinal seams under negative pressure, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84".

Diameter	U.S. Gauge
13" and less	No. 26
14" to 17"	No. 24
18" to 20"	No. 22
21" to 26"	No. 20
27" to 34"	No. 18
35" to 42"	No. 16
43" to 48"	No. 18 A6*
49" to 60"	No. 18 B4**

* A6 indicates that 1"x1"x1/8" reinforcement angles shall be used at minimum 6'-0 intervals and installed per latest edition of SMACNA HVAC Duct Construction Standards.
** B4 indicates that 1-1/4"x1-1/4"x3/16" reinforcement angles shall be used at minimum 4'-0 intervals and installed per latest edition of SMACNA HVAC Duct Construction Standards.

C. Fiberglass Duct Option. As an option, provide fiberglass duct in lieu of sheet metal for all concealed ductwork up to 36 inches wide. All duct board must have anti-microbial coating. No fiberglass ductwork will be allowed within the confines of any mechanical room. Select

heavy-density, nonmetallic duct system using 2-inch-thick fibrous glass board, with a glass fabric reinforced, embossed aluminum surface. The product must have UL Standard 181, Class I Commercial Air Duct approval. Each board must bear a UL label.

D. Flexible Ducts. Low-pressure insulated flexible duct may be used where shown on the drawings. Duct shall be made with factory preinsulated duct, covered with a minimum of 2" thick, R6 fiberglass blanket sheathed in a vapor barrier of fiberglass reinforced aluminized polyester laminate. The insulation shall have a minimum "K" factor of 0.29 at 60 degrees F mean temperature and a vapor barrier permeability rating of 0.05 per ASTM method E96-66, Procedure A. The C factor shall be 0.24 to meet HUD requirements. The duct shall be rated for a positive working pressure of 6" w.g. and a temperature of up to 250 degrees F. The duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriters™ Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U.S. Government standards; flame spread, not over 25; smoke developed, not over 50. Provide Flexmaster 1M, 8M or PeppertreeAir Solutions Type HM only (no substitutions) for flex duct at air devices, and Flexmaster Type TLM or PeppertreeAir Solutions Type TFT-M for medium and high-pressure applications i.e., connection to VAV boxes.

Low-pressure Acoustic Performance:

1. The straight duct insertion loss (db) of a 10 foot length of duct when tested in accordance with ASTM E 477 at a velocity of 2500 feet per minute shall be at least:

		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
(a)	8" dia.	12	29	36	35	38	22
(b)	12" dia	21	28	29	33	26	12

2. The radiated noise reduction (db) of a 10 foot length of duct when tested in accordance with ASTM E 477 at a velocity of 2500 feet per minute shall be at least:

		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
(a)	8" dia.	10	7	7	8	10	13
(b)	12" dia	9	6	6	5	9	13

3. The terminal ends of the duct core shall be secured by stainless steel worm gear type clamp equal to Ideal Series 56 Snaplock. The fittings on air mixing devices and on sheet metal duct shall be coated with the sealant specified for low-pressure ductwork, then flexible duct core slipped over duct and coupling or clamp tightened, then connection sealed with more sealant. Insulation of flexible duct shall be slipped over connection to point where insulation abuts mixing box or insulation on duct. These insulation connections shall be sealed by imbedding fiberglass tape in the sealant specified for medium-pressure ductwork and coating with more sealant to provide a vapor barrier. (This applies to all flex connections to diffusers, grilles, etc., when allowed on the drawings.)

E. Medium and High-pressure Insulated Flexible Duct shall be the same construction as the Low-pressure Duct, factory applied insulation of 2" minimum thickness, R6 with a permeability rating of 0.30. The duct shall be supported by a corrosion resistant metal spiral,

or a coated spring steel helix and solid inner liner mechanically interlocked or permanently bonded to the helix wire. Ratings shall be as described for Low-pressure Duct above. Flexible ducts shall be not more than 3' - 0" in length, used for alignment or sound/vibration purposes only, and may only be installed in straight runs. Flexible duct shall NOT be used for changes of direction of air flow. Installation, clamps and sealing shall be the same as specified for rigid duct and Flexmaster Type TLM or PeppertreeAir Solutions Type TFT-M for medium and high-pressure applications i.e., connection to VAV boxes.

F. Support flexible ductwork such that there is no more than 1/2" per foot deflection of duct between support points.

2.4 Medium-pressure DUCTWORK (2 INCHES THROUGH 6 INCHES STATIC PRESSURE)

Medium-pressure ductwork is defined as all ductwork downstream of all air handlers, up to and including terminal units, plus all return air ductwork, and all exhaust ductwork from the exhaust outlet to fans.

A. Rectangular. Provide rectangular, medium-pressure duct construction, gauges and reinforcing in accordance with the latest edition of the SMACNA HVAC Duct Construction Standards for 6" w.g. static pressure class (positive or negative), however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84".,

Largest Dimension	U.S. Gauge
18" and less	No. 24
19" through 48"	No. 22
49" through 72"	No. 20
73" and over	No. 18

B. Round. Use spiral-wound ducts up to 84 inches in diameter, equal to those of United McGill Sheet Metal Company, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84". Also provide fittings equal to those of United McGill Sheet Metal Company. Use the following minimum gauges for shop-fabricated spiral-wound ducts under positive pressure:

Diameter	U.S. Gauge
14" and less	No. 26
15" through 26"	No. 24
27" through 36"	No. 22
37" through 50"	No. 20
51" through 84"	No. 18

Use the following minimum gauges for shop-fabricated spiral-wound ducts under negative pressure, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 84".

Diameter	U.S. Gauge
11" and less	No. 26

12" to 14"	No. 24
15" to 22"	No. 22
23" to 26"	No. 20
27" to 36"	No. 18
37" to 42"	No. 18 F12*
43" to 60"	No. 18 F6**
61" to 72"	No. 16 F4***

* F12 indicates that 2"x2"x1/4" reinforcement angles shall be used at minimum 12'-0 intervals and installed per latest edition of SMACNA HVAC Duct Construction Standards.
** F6 indicates that 2"x2"x1/4" reinforcement angles shall be used at minimum 6'-0 intervals and installed per latest edition of SMACNA HVAC Duct Construction Standards.
*** F4 indicates that 2"x2"x1/4" reinforcement angles shall be used at minimum 4'-0 intervals and installed per latest edition of SMACNA HVAC Duct Construction Standards.

C. Oval. Furnish oval, medium-pressure ducts that are spiral; flat oval, or welded flat oval equal to those of United McGill Sheet Metal Company with gauges and reinforcing as recommended by the manufacturer for medium-pressure. Use fittings equal to those of the United McGill Sheet Metal Company. The ducts may be shop-fabricated of completely welded construction of the following minimum gauges with no reinforcing:

Minor Axis Dimension	U.S. Gauge
18" and less	No. 24
19" through 48"	No. 22
49" through 70 "	No. 20
72 " and over	No. 18

D. Medium-pressure Insulated Flexible Supply Duct. Provide factory-fabricated flexible ducts for connection between high velocity ducts and air terminal boxes consisting of an inner liner, insulation, and outer jacket. Construct the inner liner of coated steel helix and neoprene impregnated fiberglass fabric substantially bonded together to prevent the duct from collapsing or kinking in short radius bends. Provide fiberglass insulation of 2-inch minimum thickness and R6 rated around inner liner. Sheath the entire assembly in a heavy, outer vapor barrier jacket consisting of 3-ply laminate of Kraft paper, fiberglass reinforcement and aluminum foil, or closely woven fiberglass cloth impregnated with rubber or vinyl. Maximum length of flexible duct is 6 feet. Use duct rated at minimum working pressure of 10 inches of water. Provide duct listed and labeled by UL at flame spread of not more than 25 and smoke developed rate of not more than 50, and complying with NFPA Standard 90A, paragraph 113a. Acceptable products include PeppertreeAir Solutions, Thermaflex.

2.5 HIGH-PRESSURE DUCTWORK (6 INCHES THROUGH 10 INCHES STATIC PRESSURE)

A. Rectangular. Provide rectangular, high-pressure duct construction, and reinforcing in accordance with the latest edition of the SMACNA HVAC Duct Construction Standards for 10" w.g. static pressure class (positive or negative). Use the following minimum sheet metal gauges:

Largest Dimension	U.S. Gauge of Metal

48" and less	No. 22
49" through 60"	No. 20
61" through 72"	No. 18
72" and over	No. 16

B. Round. For round, high-pressure duct construction, use the same material as for round medium-pressure duct.

C. Oval. For oval, high-pressure duct construction, use the same material as for oval medium-pressure duct.

2.6 HIGH-VELOCITY LINED DUCTWORK

A. Provide double-walled, internally insulated ductwork equal to United Sheet Metal Acousti-K-27. Provide duct and fittings with solid spiral, galvanized steel, outer pressure shell, 1-inch-thick fiberglass insulation and perforated, spiral, galvanized-steel inner liner. Construct the outer pressure shell in accordance with specifications for round ductwork. Provide an assembly with effective thermal conductivity of 0.27 BTU/hr./sq.ft degree F at 75ºF mean temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Construction Standards. Use construction methods which follow the requirements outlined in paragraph 1.5, as well as SMACNA Balancing and Adjusting publications, unless otherwise indicated in these specifications or accompanying drawings.

B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.

C. Plenum Construction. Construct Plenum chambers of not less than No. 20 U.S. gauge metal reinforced with galvanized structural angles.

D. Cross Breaking or Beading. Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.

E. Wall Penetrations. Where ducts pass through walls in exposed areas, Install suitable escutcheons made of sheet metal angles as closers. At all locations where ductwork passes through floors, provide watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8-inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required. Sleeves are required inside as well as outside chases. Support ducts where passing through floors with steel structural angles of adequate bearing surface, galvanized after fabrication and resting on top of the sleeve.

F. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the section on painting. Do not Install grilles, registers, or similar items until painting is complete.

3.2 LOW-PRESSURE DUCTWORK

A. Construction. Construct rectangular ducts in accordance with the SMACNA Duct Manual.

B. Splitters. Provide adjustable, galvanized splitter-dampers pivoted at the downstream end with appropriate control device at each supply duct split, in accordance with SMACNA Duct Manual. Provide a splitter for each duct branch to two or more outlets.

C. Extractors. Provide Titus AG225 or equal extractors with an appropriate control device at each rectangular zone or branch supply duct connection in accordance with SMACNA Duct Manual.

D. Volume Dampers. Provide opposed-blade volume dampers with an appropriate control device in each return air, outside air and exhaust branch duct, in exhaust connections to hoods or equipment, in each zone at multizone unit discharge, and where otherwise indicated, in accordance with SMACNA Duct Manual. Manual balancing damper to be similar to Greenheck Model MBD-15, multi-blade, 6" maximum blade height, 16-gauge galvanized steel reinforced blades, 20-gauge frame, manual hand quadrant with standoff for externally insulated ductwork, synthetic sleeve. Dampers suitable for service to 4" w.c. for 12" width, 3" w.c. for 24" width, 2" w.c. for 36" width, 2" w.c. for 48" width and rated for 2000 fpm. Dampers larger than 96" x 96" to be similar to Greenheck Model VCD-20 series.

Manual low-leakage volume dampers shall be similar to Greenheck Model VCD-33, ultra lowl-leakage damper, rated for 6 cfm per s.f. at 4" w.c. and rated for up to 4000 fpm and up to 8" w.c. Frame to be 16-gauge galvanized, blades to be 14-gauge airfoil. Seals to be silicone-rubber for blades and flexible metal compression jamb seals. Bearings to be synthetic type. Maximum blade height is 6". Provide with manual hand quadrant with 1 ½" standoff. All volume dampers used for stairwell and vestibule pressurization shall be low leakage with blade and jamb seals.

E. Elbows.

1. Rectangular. Where square elbows are shown, or are required for good air flow, provide and Install Barber-Colman or equal double-wall air foil turning vanes. Job-fabricated turning vanes, if used, must be double thickness vanes of galvanized steel sheets of the same gauge metal as the duct in which they are installed. Furnish vanes fabricated for the same angle as the duct offset. Use radius elbows with a center line radius of not less than 1-1/2 times the duct width. Radius elbows may be provided in lieu of vaned elbows where space and air flow requirements permit.

2. Round and Oval Duct. Provide elbows with a centerline radius of 1-1/2 times the duct diameter or duct width. For round ducts, furnish smooth elbows or 5-piece, 90º elbows and 3-piece, 45º elbows.

F. Controls. For control devices concealed by ceilings, furring, or in other inaccessible locations, furnish extension rods and appropriate recessed-type Young regulators, mounted on the surface of the ceiling or the furring, unless specified, or shown otherwise. For ducts which are not concealed, or ducts which are above lay-in ceiling but accessible, provide heavy-duty, quadrant-type, adjustable regulators having wing nuts for locking in position. Saw-mark the ends of all operating rods for dampers and air control devices to indicate damper position.

G. Obstruction. Install streamline deflectors at any point where dividing a sheet metal duct around piping or where other such obstruction is permitted. Where such obstructions occur in insulated ducts, fill space inside streamliner and around obstructions with glass fiber insulation.

H. Remote Operated Dampers. Provide factory-fabricated volume dampers for remote, manual volume control. Use opposed-blade, balanced type, pivoted in bronze bearings and mounted in a channel frame. Operate damper through a flexible-drive cable from a wall-mounted operating knob. Remote operated dampers to be ultra low-leakage dampers similar to Greenheck VCD-33.

I. Fiberglass Duct.

1. Joints. Make duct system joints with mastic and tape. Reinforce according to the manufacturer's recommendations and instructions. Plain end butt joints are not acceptable.

2. Hangers. Install hangers at turns and transitions, and on not more than 6-foot centers on straight runs. Use saddle-type hangers with 3/4-inch perforated, 24-gauge straps either 22-gauge, 4-inch-long metal angles at the duct corners, or No. 12 wire, securely anchored to 2" by 1" x 24-gauge angle cross support under the duct.

3. Installation. Fabricate at job site and Install according to manufacturer's application manual and paragraph 1.5. Provide all accessories such as turning vanes, dampers, extractors, and the like, as specified for sheet metal ductwork. Off-site fabrication of ductwork or large stockpiling of fabricated sections at the job site will not be acceptable. Radius turns will not be acceptable.

J. Low-pressure Insulated Flexible Duct. Do not exceed 6 feet in length with any flexible duct. Support duct independently of lights, ceiling and piping.

K. Low-pressure Duct Supports.

1. Horizontal Ducts Up To 40 Inches. Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 22 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beamclamps or other approved means. Place supports on at least 8'-0" centers. Use clamps to fasten hangers to reinforcing on sealed ducts.

2. Horizontal Ducts Larger Than 40 Inches. Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron trapeze hangers. Place supports on at least 8'-0" centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" X 1/8"	1/4"
8'-0"	2" X 2" X 1/8"	5/16"
10'-0"	3" X 3" X 1/8"	3/8"

3. Vertical Ducts. Support vertical ducts where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60 inches. Above 60 inches the angles must be increased in strength and sized on and individual basis considering space requirements.

3.3 FLEXIBLE CONNECTIONS

A. Where ducts connect to fans or air handling units, make flexible airtight connections using "Ventglas" fabric. The fabric must be fire-resistant, waterproof and mildew resistant with a weight of approximately 30 ounces per square yard. Provide a minimum of 1/2-inch slack in the connections, and a minimum of 2-1/2-inches distance between the edges of the ducts. Also provide a minimum of 1-inch slack for each inch of static pressure on the fan system. Securely fasten fabric to apparatus and to adjacent ductwork by means of galvanized flats or draw bands. Where rectangular connections are made in outdoor locations, seal fabric to metal with mastic. For connections to belted vent sets outdoors, provide Duall fan connector, Koroseal, black with UV inhibitors. Secure with stainless steel bands.

3.4 ACCESS DOORS

A. Install ductwork access doors in structural angle frames and provide with sash locks and hinges arranged for convenient access. Construct doors which occur in insulated ducts with an insulation filler.

3.5 FLASHING

A. Where ducts pass through roofs or exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Provide flashing not less than No. 26 gauge stainless steel or 16-ounce copper.

3.6 DUCT LINING (If shown on drawings)

A. Install glass fiber acoustical lining in all rectangular low-velocity supply and return ductwork as shown on drawings. Provide 1/2-inch thick, 1-1/2 pound density, flexible lining coated on the air stream side to reduce attrition. Liner to also have an anti-microbial coating. Secure to duct surfaces with low VOC adhesive and sheet metal fasteners on 12-inch centers. Omit lining as necessary to permit satisfactory operation of air control devices. Coat all exposed edges and leading edges of cross joints with adhesive. Use liner such as Johns-Manville Lina-Coustic, or equal which meets requirements of NFPA 90-A.

3.7 DUCT LEAKAGE TESTS

A. Unless noted otherwise in paragraph below, all ductwork operating less than 2'in. w.c., to be less than 5% leakage, per SMACNA Duct Leakage Test Manual 1985. Document all tests, and forward to Engineer.

END OF SECTION

SECTION 23 33 33
ACCESS DOORS

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for furnishing and installing access doors in all wall or ceiling locations as required or shown for access to valves, controls, regulating devices, water hammer arrestors, trap primers, fire dampers, air distribution boxes and other equipment requiring maintenance, adjustment or operation. Provide access doors to provide access to all mechanical items requiring service or maintenance, whether shown on drawings or not.

1.2 WORK NOT INCLUDED

A. Doors or panels required in acoustical ceilings are provided for under Division 09. However doors required in plaster, gypboard, masonry, or other solid wall or ceiling are included under this section.

PART 2 - PRODUCTS

2.1 NON-FIRE-RATED ACCESS DOORS

A. Furnish INRYCO/MILCOR approved equal with 16- frames, 14- panels, and 22- casing bead. Provide continuous concealed hinges and flush screwdriver cam lock. Use Style K access doors for plastered surfaces, Style M for masonry or gypboard surfaces, and Style AP for acoustical plaster ceilings, with 18- panel and all galvanized construction.

2.2 FIRE-RATED ACCESS DOORS (1-1/2 HOUR LABEL DOORS)

A. Furnish INRYCO/MILCOR or approved equal UL-listed 1-1/2 HR Label "B". Access doors with 16-gauge steel frames, and 20-gauge insulated sandwich-type door panel. Provide door with an automatic closing and latching mechanism. Fire-rated access doors are required.

PART 3 - EXECUTION

A. Doors furnished by this contractor will be installed by this contractor. Not all required access doors are shown. The contractor will be responsible for proper coordination in locating access doors for ease of operation and maintenance of concealed equipment.

END OF SECTION

SECTION 23 36 00.A
AIR TERMINAL UNITS (FPVAV)

PART 1 - GENERAL

1.0 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.1 SECTION INCLUDES

A. Fan-Powered Variable Volume (VAV) Terminal Units

B. Variable Volume Regulators

C. Integral Sound Attenuator

D. Integral Controls

1.2 RELATED SECTIONS

A. Section 23 05 13 - Motors

B. Section 23 21 00 - Hydronic Piping: Connections to Heating Coils

C. Section 23 06 20.13 - Hydronic Specialties: Connections to Heating Coils

D. Section 23 31 00 - Ductwork

E. Section 23 33 00 - Ductwork Accessories

F. Section 23 37 00 - Air Outlets and Inlets

G. Section 23 09 23 - Direct Digital Control Systems

H. Section 23 05 93.A - Testing, Adjusting and Balancing

I. Section 26 05 19 - Cable, Wire and Connectors, 600-Volt

K. Section 26 27 26 - Wiring Devices and Floor Boxes

1.3 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems

B. UL 181 - Factory-Made Air Ducts and Connectors

C. ADC 1062 - Air Distribution and Control Device Test Code

1.4 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data under provisions of Section 23 00 00.

D. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.

E. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one inch wg.

F. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years’ documented experience.

1.7 WARRANTY

A. Provide one-year manufacturer's warranty under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 FAN-POWERED VAV (VARIABLE AIR VOLUME) TERMINAL UNITS:

A. Units shall be constant air volume secondary, variable air volume primary air distribution assemblies complete with casing, insulation, fan, hot water heating coil, dampers, actuators, controls, transformers, and other appurtenances required for a complete installation. Units shall be of the sizes and capacities scheduled.

B. Casing assembly shall be 22-gauge (minimum) galvanized steel. Interior surfaces of casing shall be acoustically and thermally lined with a 1” thick, 1 1/2-pound density glass fiber insulation with a smooth black coated mat finish equal to Manville “Linacoustic” Fiber Glass Duct Liner or IMCOA closed cell polymer material of equal thermal value.

Casing leakage shall not exceed 2% of the box's maximum scheduled CFM at 6" static pressure. Insulation shall be UL-listed and in compliance with NFPA 90A requirements.

C. Damper (air valve) shall have a leakage rate of less than 2% of the box's maximum scheduled CFM at two times primary supply air duct static pressure or 6" (whichever is smaller). Unit shall incorporate primary air flow sensing devices to provide input for volume regulation as indicated hereinafter.

D. Fans shall be forward curved, centrifugal, direct-drive type with 120-volt/1-phase motor and SCR controller for air flow adjustment from 60 - 100% of nominal box scheduled CFM. Fan and motor assembly shall be internally suspended and isolated from the casing on rubber in shear isolators. Fan and motor assembly shall be easily accessible through access panels without disassembling the entire unit. The SCR controller and fan motor shall be harmonically balanced to reduce electrical noise. Fan assembly shall include an anti-backward rotation device.

E. The fan-powered boxes shall be provided with a flow cross sensor located in the primary air inlet duct suitable for interfacing with the DDC system flow transducer (if required).

F. The boxes shall be provided with a 24 VAC transformer connected to the unit's incoming power source and properly protected. The transformer shall be of adequate size to provide 24 VAC power for all DDC system components associated with the box.

H. Room temperature sensors associated with these fan-powered boxes shall be furnished by the Automation Contractor (DIV. 17) and installed under Section "Direct Digital Control System".

I. The Automation Contractor (DIV. 17) shall furnish a DDC Controller and an electronic inlet damper actuator for installation on each fan-powered box by the fan-powered box manufacturer. These DDC (Direct Digital Control) devices shall be delivered to the fan-powered box manufacturer's factory in sufficient time for the manufacturer to meet its scheduled delivery obligations. The fan-powered box manufacturer shall factory mount and connect these devices as required for proper operation as required under Division 23, Section 23 09 23 and 23 09 93. The cost of factory-mounting these devices shall be included in the cost of the fan-powered boxes.

K. CONTROL PERFORMANCE: Assemblies shall be able to reset the primary air to any airflow between zero and the maximum CFM shown on Drawings. To allow for maximum flexibility and future changes, it shall be necessary to make only keyboard adjustments to arrange each unit for any maximum air flow within the ranges for each inlet size as scheduled on the Drawings. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection. All terminal units shall be installed with a minimum of four diameters of straight duct directly prior to the entry into each terminal unit connection.

L. GENERAL PERFORMANCE: Devices using mechanical CFM limiters will not be accepted, nor shall it be necessary to change control components to make airflow rate changes. If used, Automation Contractor furnished flow stations shall be furnished, mounted and adjusted by the Automation Contractor with assistance from the Terminal Unit Manufacturer to assure their proper placement. The terminal unit manufacturer shall be responsible only for the construction of the terminal unit and the installation of

internal control components installed at the manufacturer's factory, and shall not be responsible for the installation of controls not installed at the terminal unit manufacturer's factory, and shall not be responsible for the performance of the DDC controls. The performance of DDC controls, especially in connection with terminal units, shall be the responsibility of the DDC Trades and the Automation Contractor (DIV. 17).

O. DDC SYSTEMS:

1. Electronic operators and controllers shall be installed by the terminal unit manufacturer. The Direct Digital Control System Trades and the Automation Contractor shall be responsible for the operational performance of the entire system. The terminal unit manufacturer shall be responsible for the performance of the mechanical components of the unit.

2. DDC Controls Description:

a. These fan-powered boxes shall each be provided with a unit-mounted DDC terminal equipment controller (TEC) provided by the DDC Trades to accept input signals from a room space temperature sensor, the box's velocity sensor and the DDC system controller and output start/stop signals to the unit's fan, a modulating signal to the unit's primary damper, and a modulating signal to the unit's two-way modulating hot water valve as required to start/stop the unit and maintain the desired space temperature via the DDC System.

b. These fan-powered boxes served by primary air handling units shall be energized before the air handling unit is energized. The boxes shall be individually energized by the DDC System when the respective air handling unit is to operate or when a Space Sensor is below its "Low Limit" setpoint.

c. A DDC Trades furnished electronic space sensor shall modulate, through the unit's TEC, the unit's primary air damper and its respective heating coil valve as required to maintain the desired space temperature.

d. The fan-powered boxes shall be furnished by the box manufacturer complete with all necessary operating hardware and sensing devices to accept the modulating signals from the Terminal/Equipment Controller (TEC) for the unit's DDC Trades furnished electronic damper operator and DDC Trades furnished electronic control valve for the hot water heating coil and a contact closure to energize/de-energize the unit fan and controls operations.

e. Coordinate requirements for all controls components for proper operation of these fan-powered boxes with the DDC Trades.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Install in accordance with manufacturer's instructions.

C. Provide clearance for inspection, repair, replacement, and service. The mechanical contractor shall ensure all fan-powered VAV terminal unit controllers and operators are located a minimum of 30” from all obstructions (walls, pipes, etc.).

D. Provide ceiling access doors or locate units above easily removable ceiling components.

E. Support units individually from structure. Do not support from adjacent ductwork.

END OF SECTION

SECTION 23 73 00
AIR HANDLING UNITS

PART 1 – GENERAL

1.1 SYSTEM 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 draw-thru application and shall be arranged to discharge conditioned air horizontally or vertically as shown on the contract drawings.

B. Unit with a direct-expansion cooling coil shall have the capability to be used in a refrigerant circuit in conjunction with air-cooled condensing units.

1.2 QUALITY ASSURANCE

A. Unit performance shall be rated in accordance with AHRI (Air-Conditioning, Heating and Refrigeration Institute) Standard 430 for Central Station Air-Handling Units and subject to verification of rating accuracy by AHRI-sponsored, third party testing.

B. Coils shall be certified in accordance with AHRI Standard 410, latest edition.

C. Direct expansion coils shall be designed and tested in accordance with ANSI/ASHRAE (American National Standard Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers) 15 Safety Code for Mechanical Refrigeration.

D. Insulation and insulation adhesive shall comply with NFPA (National Fire Protection Association) 90A requirements for flame spread and smoke generation.

E. The management system governing the manufacture of this product is ISO 9001:2008 certified.

F. Unit shall be constructed in accordance with ETL and CSA (Canadian Standards Association) standards and shall carry the ETL and CSA labels.

1.3 DELIVERY, STORAGE AND HANDLING

Unit shall be stored and handled in accordance with the unit manufacturer’s instructions.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. General:

Unit shall be a factory-assembled, single-piece central station air handler. Unit may consist of a fan and coil section with factory-installed chilled water or direct expansion coil, preheat or reheat coil, heating coil section, filter section, mixing box or combination

filter/mixing box, or access section as indicated on the equipment schedules. Unit base rail shall be 14 gage galvanized steel.

B. Unit Cabinet:

1. Unit panels shall be constructed of 20 gage galvanized steel. Casing panels shall be removable for easy access to the unit. All panels shall be gasketed to ensure a tight seal.

2. Optional double wall construction shall be available with inner panels constructed of 20 gage steel.

3. Hinged access doors shall be double wall with 1.5 lb dual-density fiberglass between galvanized steel panels.

4. Insulation for casing panels on unit shall be 1-in. minimum thickness dual-density fiberglass insulation with a nominal density of not less than 1.5 lb per cubic foot.

5. Insulation shall be secured to casing with waterproof adhesive.

6. Condensate drain pans shall be sloped to prevent standing water and constructed of stainless steel; they shall have double wall construction with threaded drain connection.

C. Fan Section:

1. Fan sections shall be constructed of galvanized steel and shall have a formed channel base for integral mounting of fan, motor, and casing panels. Fan scroll, wheel, shaft, and bearings are to be rigidly secured to the base unit.

2. Each unit shall have a single fan wheel and scroll. Fans shall be double width, double inlet type, with forward-curved blades. Wheels shall be bonderized steel with baked enamel, or galvanized steel.

3. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed, and shall be statically and dynamically balanced as an assembly.

4. Fan shafts shall be solid steel, turned, ground and polished.

5. Fan bearings shall be self-aligning, pillow-block regreasable ball type selected for an average life of 200,000 hours at design operation conditions, per ANSI Code B3.15.

6. Fan motor shall be mounted within the fan section casing on slide rails having 2 adjusting screws. Motor shall be NEMA (National Electrical Manufacturing Association) Design B with sizes and electrical characteristics as shown on the equipment schedule.

7. Fan drive shall be designed for a 1.5 service factor and shall be factory mounted and aligned. Belt drive shall be variable or fixed-pitch type.

D. Coil Sections:

1. All coils shall have mill galvanized casings. Coils shall be factory leak tested at 450 psig air pressure.

2. Direct-expansion coils shall have aluminum plate fins with belled collars bonded to 1/2-in. OD copper tubes by mechanical expansion. Coils shall be provided with pressure-type brass distributors with solder-type connections and shall have a minimum of 2 distributors. Coils for full face active or face-split operation shall have intertwined circuits for equal loading on each circuit. Suction and discharge connections shall be on the same end. Coils shall be designed and tested in accordance with ANSI/ASHRAE 15.

E. Filter Sections:

1. Each filter section shall be designed and constructed to house the specific type of filter specified on the equipment schedule.

2. Flat filter sections shall accept filters of standard sizes. Sections shall include side access slide rails and hinged door access. Flat filter section shall be arranged with minimum depth in direction of airflow.

3. Angle filter section shall accept 2-in. filters arranged in horizontal V formation. Double-walled hinged doors shall be provided.

F. Damper Sections:

1. Mixing boxes and filter mixing boxes shall have parallel blade, interconnecting outside-air and return-air dampers. Damper blades shall have parallel bends for stiffness and shall be welded to 1/2-in. diameter steel rods rotating in nylon bushings and mounted in rigid galvanized steel frames. Dampers shall be sectionalized to limit blade width to no more than 50-in. to minimize blade warpage and to ensure tight closure. All mixing boxes and filter mixing boxes shall have double-walled hinged access doors.

2. All dampers for mixing boxes and filter mixing boxes shall be rated as low-leakage dampers, having a leakage rate not to exceed 2% of air quantity calculated at 2000 fpm velocity through damper and 4.0-in. wg pressure difference. Damper blades shall be gasketed and perimeter sealing strips shall be provided.

G. Access Sections:

1. Access sections shall be installed where indicated on the drawings and shall be as specified on the equipment schedule.

2. Access sections shall have double-walled hinged doors.

H. Special Features:

The following unit options shall be available.

1. Coil Section:

a. Chilled water coil with copper plate fins or e-coated fins and stainless steel casing.

b. Direct-expansion coil with copper plate fins or e-coated fins and stainless steel casing.

c. Hot water (U-bend) coil with copper plate fins or e-coated fins and stainless steel casing.

d. Steam distributing coil with copper fins or e-coated fins.

I. Electrical Accessories:

1. Starters:

Factory-supplied disconnects shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

a. Starter without disconnect:

1) Adjustable motor overload with trip indication.

2) Manual overload reset button (accessible without opening enclosure).

3) 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).

4) Hand/Off/Auto selector switch (accessible without opening enclosure).

5) Separate 4-position terminal strip for remote H-O-A wiring.

6) C series contactors.

7) Horsepower rated for motor applications.

8) NEMA 4X type non-metallic enclosures.

9) Lug connections for field wiring.

10) Factory mounted, wired, and run tested with factory-supplied motor.

11) UL listed.

b. Combination Starter/Disconnect:

1) Non-fused UL 508 disconnect switch with lockable handle (locks not provided).

2) Cover interlock.

3) Adjustable motor overload with trip indication.

4) Manual overload reset button (accessible without opening enclosure).

5) 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).

6) Hand/Off/Auto selector switch (accessible without opening enclosure).

7) Separate 4-position terminal strip for remote H-O-A wiring.

8) C series contactors.

9) Horsepower rated for motor applications.

10) NEMA 4X type non-metallic enclosures.

11) Lug connections for field power wiring.

12) Factory mounted, wired, and run tested with factory-supplied motor.

13) UL listed.

J. Variable Frequency Drives:

1. Factory-mounted variable frequency drives (VFDs) shall be wired to factory-supplied motors.

2. Factory-supplied VFDs are programmed and started up from the factory and qualify the VFD, through ABB, for a 24-month warranty from date of commissioning or 30 months from date of sale, whichever occurs first.

3. The VFD parameters are programmed into the controller and removable keypad. In the event that the VFD fails and needs replacement, the program can then be uploaded to the replacement VFD via the original keypad.

4. The VFD package as specified herein shall be enclosed in a UL Listed type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO 9001 facility. The VFD tolerated voltage window shall

allow the VFD to operate from a line of +30% nominal, and –35% nominal voltage as a minimum.

a. Environmental operating conditions: VFDs shall be capable of continuous operation at –15 to 40 C (5 to 104 F) ambient temperature with no frost allowed as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFDs that can only operate at 40 C intermittently (average during a 24-hour period) and therefore must be oversized. VFDs shall be capable of operating at altitude 0 to 3300 ft above sea level and less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.

b. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFDs without these ratings are not acceptable. Type 1 enclosures with only NEMA ratings are not acceptable (must be UL Type 1).

5. All VFDs shall have the following standard features:

a. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

b. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Hand” and “Auto” modes. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.

c. There shall be a built-in timeclock in the VFD keypad. The clock shall have a battery back-up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID (proportinal integral derivative loop) parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the timeclock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

d. The VFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.

e. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.

f. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).

g. The VFD shall have the ability to automatically restart after an overcurrent, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.

h. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.

i. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFDs with only one DC reactor shall add an AC line reactor.

j. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFDs with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.

k. The VFD shall include a coordinated AC transient surge protection system consisting of 4 to 120 joule rated MOVs (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

l. The VFD shall provide a programmable loss-of-load (broken belt/broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and/or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.

m. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure/jam condition causing motor overload

n. The VFD shall include multiple “two zone” PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4

to 20 mA, 0 to 10V, and/or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.

o. If the input reference (4 to 20 mA or 2 to 10 V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.

p. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

6. All VFDs to have the following adjustments:

a. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.

b. Two (2) PID set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.

c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.

d. Two (2) programmable analog inputs shall accept current or voltage signals.

e. Two (2) programmable analog outputs (0 to 20 mA or 4 to 20 mA). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.

f. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24 VDC or 24 VAC.

g. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.

h. Run permissive circuit: There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing.” The safety input status shall also be transmitted over the serial communications bus.

i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 to 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications).

j. Seven (7) programmable preset speeds.

k. Two independently adjustable accelerate and decelerate ramps with 1 to 1800 seconds adjustable time ramps.

l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.

m. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.

n. The VFD shall include password protection against parameter changes.

7. The keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:

    a. Start-up assistant

    b. Parameter assistants

    c. PID assistant

    d. Reference assistant

    e. I/O assistant

    f. Serial communications assistant

    g. Option module assistant

    h. Panel display assistant

    i. Low noise set-up assistant

    j. Maintenance assistant

    k. Troubleshooting assistant

    l. Drive optimizer assistants

8. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

    a. Output Frequency

    b. Motor Speed (RPM, %, or Engineering units)

    c. Motor Current

    d. Motor Torque

    e. Motor Power (kW)

    f. DC Bus Voltage

    g. Output Voltage

9. The VFD shall include a fireman’s override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -

500 Hz (reverse) to 500 Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.

10. Serial Communications:

a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet*. [Optional protocols for LonWorks†, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.] Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e., BTL Listing for BACnet). Use of non-certified protocols is not allowed.

b. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

1) Data Sharing – Read Property – B.

2) Data Sharing – Write Property – B.

3) Device Management – Dynamic Device Binding (Who-Is; I-Am).

4) Device Management – Dynamic Object Binding (Who-Has; I-Have).

5) Device Management – Communication Control – B.

c. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.

d. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accelerate/decelerate time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC (direct digital controls) to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable),

operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

e. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass valve control, chilled water valve / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO (digital output) and AO (analog output) commands in memory in the event the serial communications connection is lost and continue controlling the process.

11. EMI/RFI filters. All VFDs shall include EMI/RFI (electromagnetic interface/radio frequency interface) filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.

12. All VFDs through 75 hp at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.

13. Operational Functions:

a. The drive shall contain two separate acceleration/deceleration times with auto tuning for optimum setting (0.1 to 6000 seconds) with choice of linear, S, or C curves that shall be factory programmed to match the fan load and prevent nuisance overcurrent fault trips.

b. The drive shall be equipped with both local/remote and manual/auto keys on touchpad.

c. The drive shall be equipped with a quick setup key.

d. The drive shall contain 15 preset speeds, which can be activated from the keypad, terminal inputs, and host computer.

e. The drive shall have the capability of storable special custom user setting.

f. The drive shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.

g. The drive shall have adjustable soft stall (10% to 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation factory programmed for each motor's characteristics.

h. The drive shall be capable of performing a time base pattern run using 4 groups of 8 patterns each using the 15 preset speed values for a maximum of 32 different patterns.

i. The drive shall have adjustable UL listed electronic overload protection (10% to 100%) factory programmed to match each motor's FLA/RLA (full load amps/rated load amps) ratings.

j. The drive shall have a custom programmable volt/hertz pattern.

14. Protective Features:

a. The drive shall be rated for 200,000 AIC (ampere interrupting capacity). The use of input fuses to achieve this rating shall not be acceptable.

b. The drive shall have external fault input.

c. The drive shall be capable of resetting faults remotely and locally.

d. The drive shall be programmable to alert the following alarms:

1) Over torque alarm.

2) Inverter overload pre-alarm.

3) Motor overload pre-alarm.

4) Braking resistor overload pre-alarm.

5) Inverter overheat pre-alarm.

6) Undercurrent alarm.

7) Overcurrent pre-alarm.

8) Communication error alarm.

9) Cumulative timer alarm.

10) Executing retry.

e. The drive shall identify and display the following faults:

1) Overcurrent during acceleration trip.

2) Overcurrent during deceleration trip.

3) Overcurrent during normal run trip.

4) Overcurrent on the DC Bus during acceleration trip.

5) Overcurrent on the DC Bus during deceleration trip.

6) Overcurrent on the DC Bus during normal run trip.

7) Load end overcurrent trip detected at start-up (output terminals, motor wiring, etc.).

8) U-phase short circuit trip detected at start-up.

9) V-phase short circuit trip detected at start-up.

10) W-phase short circuit trip detected at start-up.

11) Overvoltage during acceleration trip.

12) Overvoltage during deceleration trip.

13) Overvoltage during normal (constant speed) run trip.

14) Inverter overloaded trip.

15) Motor overloaded trip.

16) Inverter overheat trip.

17) Emergency off trip message.

18) EEPROM failure during write cycle.

19) EEPROM abnormality during initial reading.

20) RAM error.

21) ROM error.

22) CPU error.

23) Communication interruption error.

24) Gate array error.

25) Output current detection circuit error.

26) Option PCB error trip.

27) Low operating current trip.

28) Main circuit under voltage trip.

29) Over torque trip.

30) Software detected earth fault trip.

31) Hardware detected earth fault trip.

32) Inverter type form mismatch error.

33) EEPROM type form mismatch error.

15. Monitor Functions:

a. The drive digital display shall be capable of displaying the following: Frequency, percent current, current amps, percent voltage I/O, voltage in volts I/O, RPM, GPM, I/O watts, torque, and input reference signal, kWh.

b. The drive shall have 320 programmable parameters which can be changed while the drive is operating.

c. The drive's 353 parameters shall be adjustable from the 8-key touchpad or computer link.

d. The drive's 8-key touchpad shall be NEMA 12 rated.

e. The drive's keypad shall be capable of being extended 15 ft from the drive.

f. The drive shall contain a reset of all parameters to factory default settings or user defaults (whichever one is chosen).

g. The drive shall have 2 programmable analog outputs programmable to 17 choices.

h. The drive shall have one programmable relay output programmable to 67 choices.

i. The drive shall have 8 programmable digital inputs programmable to 54 choices.

j. The drive shall have a pulse train output proportional to frequency (48, 96, 360 times frequency).

k. The drive shall have an elapsed time meter.

END OF SECTION

SECTION 23 74 00
PACKAGED ROOFTOP COOLING UNIT — VARIABLE AIR VOLUME APPLICATION

PART 1 — GENERAL

1.1 SYSTEM DESCRIPTION

Outdoor roof curb or slab mounted, electronically controlled heating and cooling unit utilizing hermetic scroll compressors with crankcase heaters for cooling duty and gas heat or electric heat. Units shall discharge supply and return air vertically or horizontally as shown on contract drawings. EERs (Energy Efficiency Ratios) shall meet requirements of ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1-2013.

1.2 QUALITY ASSURANCE

A. Unit shall be rated in accordance with AHRI (Air-Conditioning, Heating, and Refrigeration Institute) Standard 340/360, latest edition.

B. Unit shall be designed to conform to ANSI/ASHRAE 15 (latest edition), ASHRAE 62, and UL (Underwriters Laboratories) Standard 1995.

C. Unit shall be listed by ETL and ETL, Canada as a total package.

D. The 48A3,A5 units shall be designed to conform with ANSI (American National Standards Institute) Standard Z21.47 (U.S.A.) / CSA (Canadian Standards Association) Standard 2.3, Gas-Fired Central Furnaces.

E. Roof curb shall be designed to NRCA (National Roofing Contractors Association) criteria per Bulletin B-1986.

F. Insulation and adhesive shall meet NFPA (National Fire Protection Association) 90A requirements for flame spread and smoke generation.

G. The management system governing the manufacture of this product is ISO (International Organization for Standardization) 9001:2008 certified.

1.3 DELIVERY, STORAGE AND HANDLING

Unit shall be stored and handled per manufacturer’s recommendations.

PART 2 — PRODUCTS

2.1 EQUIPMENT

A. General:

Factory-assembled, single-piece heating and cooling unit. Contained within the unit enclosure shall be all factory wiring, piping, refrigerant charge (R-410A), operating oil charge, dual refrigerant circuits, microprocessor-based control system and associated hardware, and all special features required prior to field start-up.

B. Unit Cabinet:

1. Constructed of galvanized steel, bonderized and precoated with a baked enamel finish.

   a. Top cover shall be 18-gage sheet metal with 0.75-in. thick, 1.5-lb density, fiberglass insulation.

   b. Access panels and doors shall be 20-gage sheet metal with 0.5-in. thick, 1.5-lb density, fiberglass insulation.

   c. Corner and center posts shall be 16-gage galvanized steel.

   d. Basepans in the heating and return air sections shall be 16-gage galvanized steel.

   e. Basepans in the condenser section shall be 16-gage galvanized steel.

   f. Compressor rail shall be 12-gage galvanized steel.

   g. Condensate pan shall be 16-gage aluminized steel.

   h. Air baffles shall be 18-gage galvanized steel with 0.5-in. thick, 1.5-lb density, fiberglass insulation.

   i. Base rail shall be 14-gage galvanized steel.

   j. Fan deck (indoor and outdoor section) shall be 16-gage galvanized steel.

2. Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM (American Society for Testing and Materials) B117 (scribed specimen).

3. Sides shall have person-sized insulated hinged access doors for easy access to the control box and other areas requiring servicing. Each door shall seal against a rubber gasket to help prevent air and water leakage and be equipped to permit ease and safety during servicing.

4. Interior cabinet surfaces shall be sheet metal lined or insulated with flexible fire-retardant material, coated on the air side.

5. Unit shall have a factory-installed sloped condensate drain connection made from an aluminized steel or optional stainless steel.

6. Equipped with lifting lugs to facilitate overhead rigging.

7. Filters shall be accessible through a hinged access panel without requiring any special tools.

C. Fans:

1. Indoor Evaporator Fans:

    a. Double-width/double-inlet, centrifugal, belt driven, forward-curved type with single outlet discharge.

    b. Fan shaft bearings shall be of the pillow-block type with positive locking collar and lubrication provisions.

    c. Statically and dynamically balanced.

    d. Evaporator fan shaft bearings shall have a life of 200,000 hours at design operating conditions in accordance with ANSI B3.15.

    e. Solid fan shaft construction for size 020-050 units and two-piece solid fan shaft construction on the size 060 unit.

2. Condenser Fans:

    a. Fans shall be direct-driven propeller type only, with corrosion-resistant blades riveted to corrosion-resistant steel supports for all size 020-050 units and the size 060 unit with optional condenser coil. Size 060 units with the microchannel condenser coil shall have a direct driven, 9-blade airfoil cross section, reinforced polymer construction, and shrouded-axial type fans with inherent corrosion resistance.

    b. Fans discharge air vertically upward and are protected by PVC coated steel wire safety guards.

    c. Statically and dynamically balanced.

3. Supply Fan Drive:

    Unit shall be equipped with variable frequency drive (VFD) inverter. The VFD shall be installed inside the unit cabinet and shall be factory mounted, wired, and tested. The VFD shall control motor speed to maintain set point static pressure at the sensor tube location of the supply duct pressure transducer (transducer is factory provided and installed; sensor tube must be field routed). The control system may be field-adjusted to maintain supply duct static pressure set points from 0 in. wg to 3.5 in. wg.

    The variable frequency drive shall include the following features:

    a. Full digital control with direct control from the unit ComfortLink controls.

    b. Insulated Gate Bi-Polar Transistors (IGBT) used to produce the output pulse width modulated (PWM) waveform, allowing for quiet motor operation.

    c. Inverters capable of operation at a frequency of 8 kHz, so no acoustic noise shall be produced by the motor.

d. Self diagnostics.

e. Personal lockout code for additional security.

f. Critical frequency avoidance.

g. RS485 capability standard.

h. Electronic thermal overload protection.

i. 5% swinging chokes for harmonic reduction and improved power factor.

j. All printed circuit boards shall be conformal coated.

k. Shall, through ABB, qualify for a 24-month warranty from date of commissioning or 30 months from date of sale, whichever comes first.

D. Compressors:

1. Fully hermetic, scroll type compressors with overload protection and short cycle protection with minimum on and off timers.

2. Factory rubber-in-shear mounted for vibration isolation.

3. Reverse rotation protection capability.

4. Crankcase heaters shall only be activated during compressor off mode.

E. Coils:

1. Standard evaporator coil shall have aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.

2. Standard condenser coil shall be microchannel design. The coil shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Microchannel coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for the fins, tubes, and manifolds.

3. Coils shall be leak tested at 150 psig and pressure tested at 650 psig.

4. Optional condenser coil shall have aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.

5. Optional pre-coated aluminum-fin coils shall have a durable epoxy-phenolic coating to provide protection in mildly corrosive coastal environments. Coating shall be applied to the aluminum fin stock prior to the fin stamping process to create an inert barrier between the aluminum fin and copper tube. Epoxy-phenolic barrier shall minimize galvanic action between dissimilar metals.

6. Copper-fin coils shall be constructed of copper fins mechanically bonded to copper tubes and copper tube sheets. Galvanized steel tube sheets shall not be acceptable. A polymer strip shall prevent coil assembly from contacting the sheet metal coil pan to minimize potential for galvanic corrosion between coil and pan. All copper construction shall provide protection in moderate coastal environments.

7. E-coated coils shall have a flexible epoxy polymer coating uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation. Color shall be high gloss black with gloss—60 deg of 65 to 90% per ASTM D523-89. Uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges. Superior hardness characteristics of 2H per ASTM D3363-92A and cross-hatch adhesion of 4B-5B per ASTM D3359-93. Impact resistance shall be up to 160 in./lb (ASTM D2794-93). Humidity and water immersion resistance shall be up to minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to be no less than 6000 hours salt spray per ASTM B117-90. Coil construction shall be aluminum fins mechanically bonded to copper tubes.

F. Refrigerant Components:

Unit shall be equipped with dual refrigerant circuits each containing:

1. Solid core filter drier.

2. Thermostatic expansion valve.

3. Fusible plug.

G. Filter Section:

Standard filter section shall be supplied with 2-in. thick disposable fiberglass filters.

H. Controls and Safeties:

1. Unit ComfortLink Controls:

a. Scrolling marquee display.

b. CCN (Carrier Comfort Network®) capable.

c. Unit control with standard suction pressure and condensing pressure transducers.

d. Shall provide a 5° F temperature difference between cooling and heating set points to meet ASHRAE 90.1, energy standard.

e. Shall provide and display a current alarm list and an alarm history list.

f. Automatic compressor redundancy.

g. Service run test capability.

h. Shall accept input from a CO_2 sensor (both indoor and outdoor).

i. Configurable alarm light shall be provided which activates when certain types of alarms occur.

j. Compressor minimum run time (3 minutes) and minimum off time (3 minutes) are provided.

k. Service diagnostic mode.

l. Optional integrated economizer control or two-position self-closing adjustable outside-air damper.

m. Minimum of 3 capacity stages of mechanical capacity control (excluding hot gas bypass) controlled with logic to maintain supply air temperature set point.

n. Optional minimum load valve for additional capacity stage.

o. Unit shall be complete with self-contained low voltage control circuit.

2. Safeties:

a. Unit shall incorporate a solid-state compressor lockout which provides optional reset capability at the space thermostat should any of the following safety devices trip and shut off compressor:

1) Compressor lockout protection provided for either internal or external overload.

2) Low-pressure protection.

3) Freeze protection (evaporator coil).

4) High-pressure protection (high pressure switch or internal).

5) Compressor reverse rotation protection.

6) Loss of charge protection.

7) Welded contactor protection.

b. Supply-air sensor shall be located in the unit and should be used for economizer control and compressor stage control.

I. Operating Characteristics:

1. Unit shall be capable of starting and running at 115 F ambient outdoor temperature per maximum load criteria of AHRI Standard 340/360.

2. Unit with standard controls will operate in cooling down to an outdoor ambient temperature of 32 F.

3. Unit shall be provided with fan time delay to prevent cold air delivery.

J. Electrical Requirements:

All unit power wiring shall enter unit cabinet at a single location.

K. Motors:

1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
2. All condenser-fan motors shall be totally enclosed 3-phase type with permanently lubricated ball bearings, class F insulation and internal, automatic-reset thermal overload protection or manual reset calibrated circuit breakers.
3. All indoor fan and power exhaust motors 5 hp and larger shall meet the minimum efficiency requirements as established by the Energy Independence and Security Act (EISA) of 2007.

L. Special Features:

1. Ultra Low Leak Economizer:

   Dry bulb, differential dry bulb temperature, optional enthalpy, or optional differential enthalpy controlled integrated type consisting of dampers, actuator, and linkages in conjunction with control system to provide primary cooling using outdoor air, conditions permitting, supplemented with mechanical cooling when necessary.

   a. Economizer shall meet the requirements of the California Energy Commission Title 24 economizer requirements.

   b. Dampers shall be a gear-driven ultra low leakage type with blade and edge seals. Dampers shall exhibit a maximum leakage rate of 3 cfm per square foot of area at 1 in. wg pressure differential when tested in accordance with AMCA (Air Movement and Control Association) Standard 500.

2. Barometric Relief Damper Package:

   a. Package shall include damper, seals, hardware, and hoods to relieve excess internal pressure.

   b. Damper shall close due to gravity upon unit shutdown.

3. Convenience Outlet:

   Shall be factory installed and internally mounted with an externally accessible 115-v, 15 amp GFI (ground fault interrupter), female receptacle with hinged cover. A step-down transformer and overload protection shall be included so no additional wiring is necessary unless the field-wired outlet has been requested. When applied with a unit-mounted disconnect, the outlet shall be wired to the load side of the disconnect so the outlet will shut off with the disconnect.

4. Non-Fused Disconnect Switch:

   Shall be factory installed, internally mounted, and UL approved. Non-fused switch shall provide unit power shutoff. Shall be accessible from outside the unit and shall provide power off lockout capability.

5. Electric Heater (50 Series Units Only):

   Electric resistance heaters shall be factory-installed, nichrome element type, open wire coils with 0.29 in. inside diameter, insulated with ceramic bushings, and include operating and safety controls. Coil ends are staked and welded to terminal screw slots.

6. Hail Guard, Condenser Coil Grille:

   Shall protect the condenser coil from hail, flying debris, and damage by large objects without increasing unit clearances.

7. Filter Status:

   The filter status switch shall be a pressure differential switch and will indicate a dirty filter. The switch shall be available as field or factory installed.

8. Humidity Sensor:

   A humidity sensor will allow for outside air enthalpy changeover control using the standard outside air dry bulb sensor and the accessory humidity sensor. When both an outside and return air humidity sensor are used, differential enthalpy changeover can be supported.

9. Two-Position Damper:

   A two-position damper shall admit up to 25% outdoor air during fan operation and shall close when the fan is off. The damper position shall be mechanically adjustable.

10. 4-Inch Filters:

    Optional filter section shall be supplied with 4-in. thick MERV (Minimum Efficiency Reporting Value) 7 pleated fiberglass filters.

11. Control Expansion Module (CEM):

Shall provide the following additional optional features:

a. Remote set point.

b. Demand limit control.

c. Remote economizer position.

d. Fire and smoke control override control.

e. Remote sensor monitoring.

f. Fan status switch monitoring.

12. Bypass for Supply Fan VFD (Variable Frequency Drive):
Units may be equipped with an optional manual bypass switch which allows the supply fan VFD to be electrically bypassed.

13. BACnet* Communication Option:
Shall provide factory-installed communication capability with a BACnet MS/TP network. Allows integration with i-Vu® Open Control System or a BACnet Building Automation System.

14. Navigator™ Display Module:
The Navigator display module shall be a portable hand-held display module with a minimum of 4 lines and 20 characters per line, of clear English, Spanish, Portuguese, or French language. Display menus shall provide clear language descriptions of all menu items, operating modes, configuration points and alarm diagnostics. Reference to factory codes shall not be accepted. An industrial grade coiled extension cord shall allow the display module to be moved around the chiller. Magnets shall hold the display module to any sheet metal panel to allow hands-free operation. Display module shall have NEMA (National Electrical Manufacturers Association) 4x housing suitable for use in outdoor environments. Display shall have back light and contrast adjustment for easy viewing in bright sunlight or night conditions. The display module shall have raised surface buttons with positive tactile response.

15. Low Ambient Control:

a. Control shall regulate outdoor fan motor speed in response to the saturated condensing temperature of the unit. The control shall be capable of operating the rooftop unit with outdoor temperatures at –20 F.

b. Motormaster® low ambient control shall be available as a factory-installed option.

END OF SECTION

SECTION 23 81 26
AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies air-cooled condensing units complete with casing, compressor, condenser coil, condenser fan and controls required for a split air conditioning system.

1.2 RELATED WORK

A. Division 23 - HVAC. Refrigerant Piping.

B. Division 26 - Electrical. Motors.

1.3 PERFORMANCE

A. Provide performance as scheduled on drawings, and head pressure control to enable unit to operate in temperatures as low as 20°F.

PART 2 - PRODUCTS

2.1 COMPRESSOR

A. Provide a hermetic or semi-hermetic compressor with crankcase heaters, inherently protected motors, spring mounts and capacity modulation. Provide with a 5-year warranty.

2.2 CONDENSER COILS

A. Provide copper tubes with mechanically bonded aluminum fins.

2.3 FANS AND MOTORS

A. Provide propeller-type fans with direct drive or belt drive and vertical discharge. Protect fan with a heavy-gauge wire guard. Provide motors which are inherently protected, permanently lubricated, and weatherproof.

2.4 CASING

A. Furnish a unit designed for outdoor mounting. Fabricate the casing of heavy gauge steel which is zinc coated and finished with enamel. Provide removable access panels.

2.5 CONTROLS

A. Provide safety and operating controls factory wired and mounted in a separate enclosure. Include high and low pressure switches and compressor motor overload devices. Furnish a time delay device to prevent short cycling. Suction and service valves so unit can be manually pumped down.

B. Thermostat. Low voltage programmable thermostat with separate heat/cool set point, fan-on-off-auto, dead-band, after hours set points, 0-4 hr. manual override, heat-cool-off-auto.

PART 3 - EXECUTION

A. Mount condensing units on 6-inch foundation pads and pipe as shown on drawing.

END OF SECTION

SECTION 23 82 19.A
DUCTLESS MINI SPLITS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the ductless minisplit systems and accessories. It includes the ductless wall mounted indoor unit and an outdoor heat pump, similar to LG Series LS, high efficiency.

1.2 DELIVERY, STORAGE AND HANDLING

A. Unit shall be handled and stored in accordance with the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. LG, Mitsubishi, Sanyo.

2.2 CASING / FRAME

A. Outdoor unit is constructed with pre-coated metal (PCM).

B. Indoor unit is constructed of heavy duty Acrylonitrile Butadiene Styrene (ABS) and High Impact Polystyrene (HIPS) plastic.

2.3 REFRIGERANT SYSTEM

A. The refrigeration system consists of a single refrigeration circuit and uses R410A refrigerant. The outdoor unit is provided with factory installed components, including a refrigerant strainer, four-way reversing valve, electronic controlled expansion valve (EEV), high and low side charging ports, service valves, and interconnecting piping.

2.4 REFRIGERATION OIL CONTROL

A. Heat pump outdoor units have a centrifugal oil separator and controls to ensure sufficient oil supply is maintained, and that oil does not travel with the refrigerant.

2.5 COMPRESSORS

A. The outdoor unit is equipped with one hermetic digitally controlled inverter driven rotary or twin rotary compressor to modulate capacity (modulation in 1 Hz increments).

B. Overcurrent protection and vibration isolation are integrated with the compressor.

2.6 OUTDOOR UNIT COIL

A. Heat pump outdoor unit coils are made of a nonferrous construction with louvered fins on copper tubing, and are protected with an integral coil guard. Coil fans have a factory applied corrosion resistant material with hydrophilic coating.

2.7 FANS AND MOTORS

A. The outdoor unit includes one direct fan drive, variable speed propeller type fan.

B. The Brushless Digitally Controlled fan motor shall have inherent protection, permanently lubricated bearings, and variable speed with a maximum speed up to 950 rpm. Raised guards are provided to limit contact with moving parts. The outdoor unit has horizontal discharge airflow.

2.8 ELECTRICAL

A. These units are available in 208-230V, 60 Hz, 1-phase power supply. These units are capable of operating within voltage limits of ± 10% rated voltage, and include overcurrent protection.

2.9 CONTROLS

A. These units are factory wired with necessary electrical components, integral microprocessors, printed circuit boards, thermistors, sensors, terminal blocks, and lugs for power wiring.

B. Microprocessor-based algorithms provide component protection, soft-start capability, refrigeration system pressure, temperature, defrost, and ambient control.

PART 3 - EXECUTION

A. Install all components, piping, power and control wiring, per manufacturer's installation instructions. Install outdoor unit on thycurb equipment pads.

END OF SECTION

SECTION 26 00 00
ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Architectural Plans and Specifications, the General Conditions, Supplementary General Conditions and other requirements of Division 01, the Structural Plans and Specifications, the Mechanical Plans and Specifications, and the Electrical Plans apply to the work specified in the Electrical Sections, and shall be complied with in every respect. The Contractor shall examine all of these documents, which make up the Contract Documents, and shall coordinate them with all electrical work on the Electrical plans and in the Electrical Sections of these Specifications.

1.2 SUMMARY

A. The work covered by the electrical specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, utilities, and incidentals necessary for the complete installation of all electrical work required in the contract documents and specified herein. The intent of the contract documents is to provide an installation complete in every respect. In the event that additional details or special construction may be required for the work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and labor which is usually furnished with such systems in order to make the installation complete and operative.

B. The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of other trades. The Contractor shall visit the site and thoroughly familiarize himself with the existing conditions that affect the work and to verify all dimensions. The Contractor shall advise the Architect of any discrepancy prior to bidding. The submission of a bid shall be deemed evidence of the Contractors site visit, the coordination of all existing conditions, and the inclusion of all consideration for existing conditions.

C. Electrical services and connections to motors and appliances furnished by others including, but not limited to, heating ventilation and air conditioning equipment, plumbing equipment and associated controls, and equipment specified by other specification divisions included in the Construction Documents.

1.3 DRAWINGS AND SPECIFICATIONS

A. These Specifications are accompanied by Drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, light fixtures, switch controls, receptacles, etc. The Drawings and these Specifications are complementary to each other, and what is required by one shall be as binding as if required by both. Phase, neutral and switch leg indications are shown only where it is considered that clarification is required to indicate typical wiring methods required.

B. If any departures from the contract documents are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted in writing to the Architect for review. No departures shall be made without prior written approval of the Architect.

C. The interrelation of the Specifications, the Drawings, and the Schedules is as follows: The Specifications determine the nature and quality of the materials, the Drawings establish the quantities, dimensions and details, and the Schedules give the performance characteristics. Should the Drawings disagree in themselves, or with the Specifications, the better quality or greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Architect in writing, shall be performed or furnished. In case the Specifications should not fully agree with the Schedules, the latter shall govern. Figures indicated on Drawings govern scale measurements and large scale details govern small scale Drawings. In case of disagreement between Specifications and Drawings, see Division 1 of these Specifications for clarification.

D. Items specifically mentioned in the specifications but not shown on the contract drawings and/or items shown on the contract 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.

1.4 CODES AND STANDARDS

A. All work shall comply with the applicable rules and regulations of the National Electrical Code, the National Electrical Safety Code, the National Fire Codes (published by National Fire Protection Association), American with Disabilities Act Regulations, the Local Authority Having Jurisdiction, the terms and conditions of services of the electrical utility, as well as any other authorities that may have lawful jurisdiction pertaining to the work specified. None of the terms or provisions of this specification shall be construed as waiving any of the rules, regulations, or requirements of these authorities.

B. In any instance where these Specifications call for materials of a better quality or larger size than required by the codes, the provisions of these Specifications shall take precedence. The codes shall govern in case of direct conflict between the codes and the specifications.

1.5 REQUEST FOR INFORMATION

A. The Contractor may, after exercising due diligence to locate required information, request from the Consultant clarification or interpretation of the requirements of the Contract Documents. The consultant shall respond to such Contractor's requests for clarification or interpretation. However, if the information requested by the Contractor is apparent from field observations, is contained in the Contract documents or is reasonably inferable from them, the Contractor shall be responsible to the Owner for all reasonable costs charged by the consultant to the Owner for the Additional Services required to provide such information.

1.6 CONTRACT CHANGES

A. When submitting proposed changes, both additive and deductive, the Contractor shall include and set forth in clear and precise detail, a breakdown of labor and materials along

with estimated impact on the construction schedule. Contractor shall furnish spreadsheets that include quantities, unit costs and extensions. Any special equipment, i.e., fixtures, switchgear, special systems included in change proposal, shall be listed separately on vendor-supplied quote with detailed itemization and unit costs, with additions and deletions listed separately.

1.7 TEMPORARY SERVICES

A. At present, electrical service exists on this site which may be used for temporary construction power. It shall be the responsibility of the Contractor to provide a complete system for temporary electrical power service and distribution. The Electrical Contractor shall provide the necessary wiring, connections, service switches, poles, wiring protective devices, lighting fixtures, lamps, outlet devices, disconnect switches, etc., as required for temporary lighting. In addition, a similar system shall be provided for the distribution of single and three phase power of voltage levels and adequate ampacity as required to facilitate the construction of the project. These services shall be installed in accordance with requirements of the National Electrical Code (NEC), the Occupational Safety and Health Administration (OSHA), and the National Electrical Safety Code (NESC).

B. Coordinate all temporary power connections points with the owner. In no instance shall temporary power interfere or disrupt the owner's activities.

C. Remove all temporary wiring upon completion of the work.

1.8 BUILDING CONSTRUCTION

A. It shall be the responsibility of the Contractor to consult the Architectural and Engineering Drawings and Details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.

B. The electrical drawings are diagrammatic in character and cannot show every connection in detail or every line or conduit in its exact location. These details are subject to the requirements of local ordinances and also structural and Architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate with all other trades in order to avoid interference between the various phases of work.

C. The approximate location of electrical items is indicated on the electrical drawings. These drawings are not intended to give complete and exact details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the job site and will in all cases be subject to the approval of the Architect. The Architect reserves the right to make any reasonable changes in the location indicated without additional cost.

1.9 BUILDING DEMOLITION

A. Unless noted otherwise, remove all electrical materials and equipment from areas designated for demolition.

B. Where electrical equipment is indicated for removal, the Contractor shall remove all associated wiring back to the last active outlet or to the panelboard. If all electrical equipment on the circuit is scheduled for removal, the Contractor shall remove the

associated conduit system where run exposed or accessible in ceilings or floor plenums. Where conduit is concealed in walls, floors or ceilings the exposed portion of the conduit shall be cut off flush with the building surface and the concealed portion shall be capped and abandoned in place. All voids left by the removal of electrical equipment shall be filled with grout and finished to match existing adjacent surfaces. Removal of any electrical equipment shall be performed in such a way not to interfere with ongoing daily building operations.

C. All salvage shall remain the property of the Owner and be delivered to a location, on site, as designated by the Owner. In the event the Owner does not desire to retain the salvage material, the material becomes the property of the Contractor and shall be disposed of by the Contractor.

D. Existing electrical services and controls to items being removed by others must be disconnected as a requirement of this section.

E. Wherever a new to existing electrical connection is required, the Contractor shall provide all materials (e.g., junction boxes, conduit, fittings, wiring and wiring connections) and labor required to make the connections.

F. The Contractor shall be responsible to maintain all branch circuits, in an operational condition, in all areas not included under this contract that may be affected during the demolition.

G. All concrete slab penetrations shall be coordinated and approved by the structural engineer. The Contractor shall X-ray the proposed slab penetration area prior to performing any work, to ensure that there are no existing conduit systems, concrete load bearing structural members, etc., that may otherwise be damaged by core drilling the concrete slab.

H. The Contractor shall field verify power connection points of devices not scheduled for removal, by means of circuit tracing, prior to any rewiring. Equipment and devices not scheduled for removal and their associated branch circuitry shall remain in their original operating condition.

I. The Contractor shall provide new wiring for all branch circuits and feeders. Splicing new wiring to old wiring is not acceptable. Existing conduit system may be reused and extended as required unless visible conduit damage is noted, in which case the existing conduit system shall be replaced with a new conduit system.

1.10 CONTRACTOR QUALIFICATIONS

A. An acceptable contractor for the work under this division shall be a specialist in this field and have the personal experience, training, skill and the organization to provide a practical working system. If required, he shall be able to furnish acceptable evidence of having contracted for and installed not less than three systems of comparable size and type to this one, that have served their owners satisfactorily for not less than three years.

B. The foreman or superintendent for this work shall have had experience in installing not less than three such systems and shall be approved by the Architect before the work is begun.

Adequate and competent supervision shall be provided to ensure first class workmanship and installation.

C. Work shall be executed and all materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed.

D. The Contractor shall be responsible for all construction techniques required for all electrical systems specified and shown on the drawings.

1.11 OBSERVATION OF THE WORK

A. Architect's authorized representative and/or owner's observer shall have the right to observe the work at any time. The contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the architect's representative. Recommendations made by observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced to the satisfaction of the Architect.

1.12 SHOP DRAWINGS AND PRODUCT DATA

A. Submit shop drawings and product data as specified in Division 1 - General Requirements. Submittal data shall indicate the manufacturer's name, published performance, ratings and/or capacity data, detailed equipment drawings for fabricated items, wiring diagrams, installation instructions and other pertinent data. All submittals shall bear the specification section number they are related to or the specific sheet where products are shown on the contract drawings which are not referenced by the specifications. Where literature is submitted covering a group or series of similar items, the applicable items must be clearly indicated. Submittals shall be clearly marked highlighting all proposed equipment and devices to be used in this project. Submittals that do not comply with all requirements will be returned without review. Shop drawings shall note all deviations from contract documents.

B. Submittal review is only for general conformance with design concept of project and general compliance with the contract documents. The Contractor is responsible for conforming and correlating equipment dimensions at job site; for information which pertains to fabrication processes or construction techniques; and for coordination of work of all trades. Review of submittals shall not relieve the Contractor of responsibility for deviation from requirements of contract documents or errors of omissions in submittals.

C. The submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of the specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the specified system performance.

D. Contractor's Check. Submittal of shop drawings, product data and samples will be accepted only when they are submitted by the Contractor. Each submittal shall indicate by signed

stamp that the submittals have been checked and that they are in accordance with contract documents and that dimensions and relationship with work of other trades have been checked. Submittals that have not been checked and signed by the Contractor will be returned for checking before being reviewed.

E. Engineer's review of submittals constitutes an acknowledgment only and in no way relieves the contractor of full responsibility for providing all systems in accordance with the intent of the contract documents. Any material provided by this contractor without approved shop drawings constitutes the contractor's agreement to comply with the engineer's intent whether specified, shown or implied.

F. Organize data in a 3-ring binder indexed by specification section. Show any revisions to equipment layouts required by use of selected equipment.

G. Submittals are required for, but not limited to, the following items:

1. Product Data.

(a) Boxes.

(b) Enclosed circuit breakers.

(c) Enclosed safety switches.

(d) Grounding materials and equipment.

(e) Insulated conductors.

(f) Metal framing.

(g) Raceways.

(h) Wiring devices.

1.13 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Contractor's Options.

1. For products specified only by reference standard, select any product meeting that standard.

2. For products specified by naming several products or manufacturers, select any one of the products or manufacturers named, which complies with the specifications.

3. For products specified by naming one or more products or manufacturers and "or equal," Contractor must submit a request for substitutions for any product or manufacturer not specifically named.

4. For products specified by naming only one product and manufacturer, there is no option.

B. Manufacturers' names and catalog numbers specified under sections of Division 16 are used to establish standards of design, performance, quality and serviceability and not to limit competition, nor to discriminate against an "approved equal" product of another manufacturer. Equipment of equal design to that specified, will be acceptable upon approval by the Engineer. The Architect/Engineer will consider written requests for substitution of specified products, if reviewed fourteen days prior to bid date. After bid date, request for substitution will be considered only in cases of product unavailability or other conditions beyond control of the contractor. It shall be the contractor's responsibility to:

1. Personally investigate the proposed substitute product to determine that it has all the same accessories and is equal or superior in all respects to that specified.

2. Provide the same guarantee for the substitution that he would for that specified.

3. Coordinate the installation of the equipment which he proposes to substitute with all trades and includes the costs for any changes required for the work to be complete in all respects. The contractor will prepare shop drawings where required by the Architect/Engineer or where dimensions vary.

4. Provide itemized cost breakdown including material and labor for the proposed product substitutions. Submit complete design and performance data.

1.14 PROJECT RECORD DOCUMENTS

A. Throughout progress of the work of this Contract, maintain an accurate record of all changes in the Contract Documents. Upon completion of the Work of this Contract, transfer the recorded changes to the AutoCad drawing files and specification word processing files. Delegate the responsibility for maintenance of Record Documents to one person on the Contractor's staff. Thoroughly coordinate all changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to properly show the change. Include all addenda items, request for information Architect’s Supplemental Instructions and any other document that causes a change in the Construction Documents. Accuracy of records shall be such that future search for items shown in the Contract Documents may reasonably rely on information obtained from the approved Record Documents.

B. The Contractor shall mark any deviations on a daily basis. The Architect will visit the site and will require to see the "As-Built" documentation periodically. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Record installed feeder conduits. Dimension the location and elevation of the conduit.

C. Record Documents shall consist of the following:

1. Job Set: Promptly following award of Contract, secure from the Architect, at no charge to the Architect, one complete set of all electrical documents comprising the Contract.

2. Final Record Documents: Obtain the AutoCad drawings files and the specification word processing files at the Contractor’s expense.

(a) The Contractor shall transfer all change data shown on the job set of to the corresponding electronic files, coordinating the changes as required, and clearly indicating at each affected detail and other drawing the full description of all changes made during construction and the actual location of items. Call attention to each entry by drawing a "cloud" around the area or areas affected.

3. Submit the completed total set of Record Documents to the Engineer as described above. Participate in review meeting or meetings as required by the Engineer, make all required changes in the Record Documents, and promptly deliver the final Record Documents to the Architect. Upon completion of Work, the Contractor shall certify the "Record Drawings" for correctness by signing the following certification:

CERTIFIED CORRECT (3/8" high letters)

(Name of the Contractor)

By _____

Date _____

(Name of the Sub-Contractor)

By _____

Date _____

D. Deliver record drawings to the Architect in the number and manner specified in Division 1 - General Requirements.

1.15 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Prepare and submit sets of product data, shop drawings, wiring diagrams, instructions and parts lists for operating and maintaining the electrical equipment and systems installed. Also include all approved submitted data, all warranties on equipment, contractor's warranty. Deliver manuals and tools to the Architect as a condition of final acceptance. Refer to Division 01 for other requirements. The Owner's manual shall include:

1. Manufacturer's installation instruction brochures.

2. Manufacturer's local representative and/or distributor's name and address.

3. Manufacturer's operating and maintenance brochures.

4. Replacement part number listings and/or descriptions.

5. Manufacturer's warranties and guarantees.

B. This manual shall include all of the listed data bound into a permanent hard-back, three ring binder(s) identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of Building, the Owner, the Architect, the Engineers, the General Contractor, and the Contractors installing equipment represented in the brochure.

C. Contents of the manual shall be grouped in sections according to the various sections of Division 16, and shall be listed in a Table of Contents. Sections shall be organized as follows:

1. Each "tab" in the brochure shall identify the grouping of all literature required for a single class of equipment; i.e., "transformers", "lighting fixtures", "switchgear", etc., for all types of equipment on the job.

2. Contents under each "tab" shall refer to a single class of equipment, and shall be arranged in the following sequence: First, the manufacturer's installation brochure; second, the manufacturer's operating and maintenance brochure; third, the manufacturer's installation wiring diagram; fourth, the Contractor's field wiring diagram; if different, and fifth, the manufacturer's brochure listing replacement part numbers and description.

3. Provide final tab "Warranties and Guarantees" behind which all such items will be located.

D. Upon completion of the work and at a time designated by the Architect, instruct the Owner's operating personnel in operation and maintenance of electrical equipment and systems. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Architect. At the conclusion of the instruction, obtain the signatures of the people instructed on each copy of the outline to signify that they have a proper understanding of the operation and maintenance of the system. Submit the signed outlines to the Architect as a condition of final acceptance. Provide a minimum of 4 hours of general instruction in addition to any time specified in other sections of Division 26.

PART 2 - PRODUCTS

2.1 CONSTRUCTION MATERIALS

A. All materials shall be new and shall conform to the National Electrical Code and National Fire Protection Association requirements and shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency.

2.2 STANDARD PRODUCTS

A. All materials and equipment shall be standard catalog products of domestic manufacturers regularly engaged in the manufacture of products conforming to these specifications. Materials and equipment shall have been in satisfactory use at least two years prior to bid

opening. Where custom or special items are required, these shall be fully described by drawings and/or material list which detail the item proposed for use on this project.

2.3 MANUFACTURERS' INSTRUCTIONS

A. The Contractor is fully responsible for furnishing the proper electrical equipment and/or material and for seeing that it is installed as intended by the manufacturer's written instructions. If needed for proper installation, operation, or start up, the Contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning all materials and equipment. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the contract documents and the manufacturer's directions and shall obtain the Architect's instructions before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or instructions from the Architect, he shall bear all costs arising in connection with correcting the deficiencies.

2.4 RUST PREVENTION

A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus shall be given a rust inhibiting treatment and standard finish by the manufacturer. All parts such as boxes, bodies, fittings, guards, and miscellaneous parts shall be protected in accordance with the ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

2.5 CAPACITIES AND SPACE LIMITATIONS

A. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions. Where approved equipment requires electrical power other than that indicated in the contract documents for the specified equipment, the Contractor shall be responsible to adjust protective devices, starter sizes, conductors, conduits, etc., to accommodate this approved device electrically.

B. The Contractor shall be responsible to verify that the equipment he proposes to provide will physically fit within the space indicated on the contract documents and that the required code clearances and maintenance access are maintained. Any space conflicts shall be noted in the submittals. Provide scale drawings to the Architect indicating proposed solutions to any space conflict for the Architects review and approval.

2.6 NAMEPLATES

A. Each piece of equipment shall have a nameplate from the manufacturer with the following information: name, address, catalog number, voltage, phase, full load amperes or horsepower, and/or other pertinent information on a plate securely attached to the equipment. All data on nameplates shall be legible at the time of final inspection.

PART 3 - EXECUTION

3.1 DELIVERY STORAGE AND HANDLING

A. The Contractor shall not receive any equipment at the job site until the equipment is ready to be installed or until there is suitable space provided to properly protect equipment from rust, weather, humidity, dust, and physical damage.

B. All equipment shall be protected in accordance with the manufacturer's recommendations and the requirements of NFPA 70B, Appendix I, titled "Equipment Storage and Maintenance During Construction". The Contractor shall replace all damaged or defective equipment with new equipment.

C. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of final acceptance, shall be replaced by this Contractor.

3.2 PROTECTION OF EQUIPMENT

A. During construction, protect switchgear, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually.

B. Keep products clean by elevating above ground or floor and by using suitable coverings.

C. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

D. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore any finishes that become marred or damaged.

3.3 INSTALLATION

A. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work. The Contractor is responsible to coordinate with other trades in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades. Provide coordination drawings showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

B. Provide 4-inch thick concrete housekeeping pads for indoor floor-mounted equipment, except where direct floor mounting is required. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3-inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.

C. All equipment shall be installed plumb and level. Sheet metal enclosures shall be separated from walls by not less than a 1/4-inch air gap provided by corrosion-resistant spacers. Provide corrosion-resistant bolts, nuts and washers to anchor equipment.

D. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:

1. Where shown or specified to be exposed. Exposed is understood to mean open to view.

2. Where exposure is necessary to the proper function.

3. Where size of materials and equipment preclude concealment.

E. All equipment shall be installed in a manner to permit access to parts requiring service. All electrical equipment shall be installed in such a manner as to allow removal for service without disassembly of other equipment.

F. All electrical equipment shall have working clearances as required by the latest version of the National Electrical Code.

3.4 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. The Contractor shall provide all hoisting, scaffolding and ladders as required to set the equipment in place in the building.

B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to project.

3.5 CLEANING

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the site and from any street or alley adjacent to the site.

B. At completion of the project, the Contractor shall remove all of his tools, scaffolding, and surplus materials.

3.6 CONDUIT SLEEVES AND PENETRATION SEALS

A. Where conduits pass through walls or floors not on fill, galvanized sheet metal sleeves shall be used. In walls, they shall be flush with each finished surface. In pipe chases, they shall extend 1-1/2" above floor slab and be cemented in a water tight manner. Size of these sleeves shall be at least ½" greater than outside diameter of the conduit.

B. For conduits passing through outside walls, the conduit to wall penetration closures shall be "Link-Seal" as manufactured by Thunderline Corporation or Crouse Hinds. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and wall opening. Seals located underground shall be manufactured from stainless steel. Links shall be loosely assembled with bolts to form a continuous rubber belt around the conduit with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight

seal between the conduit and wall opening. The seal shall be constructed so as to provide electrical insulation between the conduit and wall, thus reducing chances of cathodic reaction between these two members.

1. Contractor shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the conduit and Link-Seal to assure a water-tight joint. Sizing (correct Link-Seal model and number of links per seal) may be obtained through manufacturer's catalog. If conduit O.D. is non-standard due to coating, insulation, etc., consult Thunderline's factory for engineering assistance and recommendation before proceeding with wall opening detail.

2. Contractor shall familiarize his installing personnel with Link-Seal instruction bulletin (packed with each carton) which illustrates the proper procedure for installing and tightening the seal to provide a water-tight conduit penetration.

3. Provide fire rating to meet or exceed fire rating of penetrated wall.

C. Pipe and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided for roof penetrations. All roof penetrations shall be reviewed and approved by the Architect.

3.7 FIRE STOPPING

A. All conduits, cables, cable tray, etc. passing through fire rated floors and/or walls shall have the void area between the material passing through floor and/or wall sealed with an approved fire-stop material to maintain the fire rating of the floor and/or wall. Depending on the particular installation, the contractor shall use FS900 series fire stop caulk or FS500/600 series fire-stop components as manufactured by International Protective Coatings or approved equivalent.

B. All fire stop systems shall be installed as required by the manufacturer and U.L. requirements for each application.

C. The Contractor shall procure the services of an independent inspection service to review and provide a certified letter to the Contractor, Engineer and the City of San Antonio, stating all fire stopping has been installed per UL listing and the manufacturer’s recommendations. Independent service shall have experience in the inspection of fire stopping materials and methods installed.

3.8 ACCESS DOORS

A. Furnish and install access doors in all inaccessible wall or ceiling locations as required for access to conduit bodies, junction and pull boxes, outlet boxes, and other electrical equipment requiring maintenance, adjustment or operation. Doors or panels required in acoustical ceilings are provided for under Division 09. However doors required in plaster, gypboard, masonry, or other solid wall or ceiling are included under this paragraph. Access

doors are not indicated on the drawings. The contractor will be responsible for proper coordination in locating access doors for ease of operation and maintenance of concealed equipment.

B. Non-fire-rated access doors.

1. Furnish INRYCO/MILCOR approved equal with 16-gage frames, 14-gage panels, and 22-gage casing head. Provide continuous concealed hinges and flush screwdriver cam lock. Use Style K access doors for plastered surfaces, Style M for masonry or gypboard surfaces, and Style AP for acoustical plaster ceilings, with 18-gage panel and all galvanized construction.

C. Fire-rated access doors (1-1/2 hour label doors).

1. Furnish INRYCO/MILCOR or approved equal UL-listed 1-1/2 HR Label "B". Access doors with 16-gage steel frames, and 20-gage insulated sandwich type door panel. Provide door with an automatic closing and latching mechanism. Fire-rated access doors are required.

3.9 ELECTRICAL CONNECTIONS TO MOTORS, EQUIPMENT AND CONTROL SYSTEMS

A. Contractor shall coordinate with Division 15 and other divisions as required to verify all electrical requirements of those divisions. This is to include, but not be limited to, verification of power, voltage, phase and other characteristics as being compatible with that called for on the electrical drawings and Division 26 specifications, as well as that called for in Division 15 drawings and specifications or other divisions requiring electrical connections. This shall be done prior to placing orders for equipment or material, and prior to any rough-in, etc.

B. Motors are specified in Divisions 22 and 23. Electrical work includes the electrical connection of all motors, except those which are wired as a part of equipment. Connection of motors specified in Divisions 22 and 23 but not reflected on electrical drawings shall be included in division 26 scope of work.

C. The contractor shall refer to and coordinate with Divisions 22 and 23 and other divisions included in the construction documents all interlock interfacing with any and all control systems. The contractor shall furnish and install all wiring, conduit required to interlock, interface and connect all control systems in the project.

3.10 CUTTING AND PATCHING

A. Where it becomes necessary to cut through any wall, floor, or ceiling to install any work under this Section of the Contract, or to repair any defects that may appear up to the expiration of the guarantee period, such cutting shall be done under the supervision of the Architect by this Contractor. This Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect.

B. Patching of all openings cut by this Contractor, or repairing of any damage to the work of other trades caused by cutting or by the failure of any part of the work installed under this

Contract, shall be performed by the appropriate trade but shall be paid for by this Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements. All openings shall be waterproofed upon completion of the work as specified by the architect. Any openings through fire rated walls or floors shall be sealed to meet the minimum fire rating of wall or floor penetrated.

3.11 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities as used by his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices and receive written permission from the Owner to enter existing areas. Before beginning work in existing areas, make the necessary arrangements and perform other services required for the care, protection, and in service maintenance of all electrical, communication, plumbing, heating, air conditioning, and ventilating services for existing facilities. The Contractor shall erect temporary barricades with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

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

C. Where existing construction is removed to provide working and extension access to existing utilities, the 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.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed and equipment located in these areas is required to remain in operation, the Contractor shall remove and reinstall all equipment required for the operation of the remaining electrical systems. This is to include but is not limited to electrical switches, relays, fixtures, conduit, etc.

3.12 OUTAGES

A. Outages of services as required by the project will be permitted but only at time approved by the Owner. The Contractor shall notify the Owner in writing two weeks in advance of the requested outage in order to schedule required outages. No outages shall be taken unless written approval has first been received from the Owner. 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.

3.13 TESTING

A. Tests to be completed by the Contractor shall be of two types. During construction, system testing shall be accomplished to determine whether systems are suitably wired, and if

systems operated as specified. Later, demonstration testing shall be accomplished for the purpose of showing that the systems operated as designed.

1. Provide records of tests for individual tests as required below. The tests records shall include the results of the test, and the persons conducting. These tests shall be included in the Operation and Maintenance Manual under the test section.

2. Following each demonstration test, a certified record of each test shall be made. All demonstration testing shall be witnessed by the Architect or his representative and the owner's representative. The records of the demonstration testing shall be signed by the persons conducting and witnessing the test. Demonstration tests will not be considered complete unless a signed certificate is provided for each test.

3. The Contractor shall provide all test equipment, temporary wiring, labor, etc., required to perform the testing.

B. System Tests

1. After the branch circuit conductors have been installed, but before they have been connected to the associated wiring devices, test all conductors for short circuits, open circuits. These tests shall be performed by reading resistance in ohms with a multi-meter.

2. After feeder conductors have been installed, but before they have been terminated, test all conductors for short circuit, open circuits and insulation resistance. The short circuit and open circuit test shall be performed by reading resistance in ohms with a multi-meter. The insulation resistance test shall be performed by reading resistance to ground in ohms with a megaohm meter. Submit test results in the Operation and Maintenance Manuals.

3. Any wiring device, lighting fixture or electrical apparatus if grounded or shorted in an integral "line" part, shall be removed and the trouble corrected or device replaced.

4. Systems such as fire alarm shall be tested by the system supplier. Following the test, provide an affidavit that the system has been tested by him, and that the system is complete and operational as specified.

5. For all new extensions of the existing power distribution system, system voltages shall be measured and recorded under maximum load conditions available during construction. Transformer secondary voltages shall be checked and adjusted to be equal to the voltage rating, or not exceeding 2-1/2% above the voltage rating. Line-to-line voltages should be adjusted between 208 and 213 volts. A record of each final test along with time of day, date, and conditions of loading should be recorded for each test location. Submit test results in the Operation and Maintenance Manuals.

6. Test for load division between all conductors in parallel feeders. The difference in current carried between the individual feeders comprising the parallel feeder shall not exceed 10% of feeder current. Records shall indicate amperage, voltage, and

feeder identification. Any feeder not in compliance shall be modified to correct the load division to within 10% and shall be retested. Submit test results in the Operation and Maintenance Manuals.

7. The Contractor shall test all receptacles for power polarity and ground to assure that all receptacles are operating properly, correctly wired and suitably grounded. Provide an affidavit to the effect that this work has been accomplished.

8. Do not subject Ground Fault Interrupter (GFCI) type breakers or receptacles to megger tests.

C. Demonstration Test of Completed Systems. Demonstrate the features and operation of the following systems:

1. Communications systems.

   (a) Fire alarm systems.

2. Electrical entrance equipment:

   (a) Switching.

   (b) Operation of circuit breakers.

   (c) Ground fault protection devices.

3. Electrical system and control and equipment:

   (a) Power distribution equipment.

   (b) Motor control devices.

   (c) Contactors.

   (d) Panelboards.

D. Each system shall be demonstrated once only, after completion of satisfactory testing and acceptance.

E. The demonstration shall be held upon completion and acceptance of all systems at a date to be agreed upon in writing by the Architect.

F. The demonstration shall be held by the appropriate Contractors in the presence of the Architect or his representative and the manufacturer's representative.

G. Demonstrate the functions and location (in the structure) of each system, and indicate its relationship to the riser diagrams and drawings.

H. Demonstrate by "start-stop operation" how to work the controls, how to reset protective devices, how to replace fuses, and what to do in case of emergency.

I. Check rotation of all equipment and correct if necessary.

3.14 CONDITIONS OF EQUIPMENT AT FINAL ACCEPTANCE

A. At time of acceptance, the Contractor shall have inspected all installed systems to assure the following has been completed:

1. Fixtures are operating, lenses and reflectors are free of dust, debris, and fingerprints.

2. Panelboards have all conductors neatly formed, laced and made-up tight. Enclosures shall be vacuum cleaned, surfaces clean of stray paint, dust, grease and fingerprints. All circuit directories to be neatly typed and in place.

3. Wall plates and exposed switch and receptacle parts to be clean, free of paint, plaster, etc.

4. Safety and disconnect switches and motor starters to be vacuum cleaned of debris, dust and all surfaces free of stray paint, grease and fingerprints.

5. Switchgear, transformers and system devices shall be cleaned internally and externally and have all surfaces restored to initial surface conditions.

6. Touch-up all scratched surfaces using paint matching the existing equipment paint. Where paint cannot be matched, the entire surface shall be repainted in a color and manner approved by the Architect.

7. All electrical equipment shall bare proper labeling as specified under this section.

3.15 GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of twelve (12) months after the final acceptance of work.

END OF SECTION

SECTION 26 05 19
INSULATED CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies the furnishing and installation of 600 volt insulated conductors.

1.2 REFERENCE STANDARDS

A. ANSI/UL 83 - Thermoplastic-insulated Wires.

B. ICEA S-61-402 (NEMA WC 5) - Thermoplastic-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.3 APPLICABLE PROVISIONS

A. Refer to Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Submit manufacturer's data on electrical wires, cables connectors and accessories.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, acceptable manufacturers shall be as follows:

1. Copper Insulated Conductors.

(a) American Insulated Wire Corporation.

(b) Encore Wire Ltd.

(c) Southwire Company.

(d) Senator Wire & Cable Company.

(e) United Copper Industries.

2. Aluminum Insulated Conductors.

(a) Alcan Cable.

(b) Southwire Company.

3. Wire Connectors.

(a) Burndy.

(b) 3M Electrical Products Division.

(c) Ilsco.

(d) Ideal.

(e) Thomas & Betts.

2.2 600-VOLT INSULATED CONDUCTORS

A. All branch circuit conductors and feeder conductors 2/0 AWG and less shall be soft-drawn annealed copper with conductivity of not less than 98% at 20 degrees C (68 degrees F). Feeder conductors greater than 2/0 AWG copper may be converted to aluminum at the contractor's option. Feeders shall be as defined in the NEC. The contractor shall be responsible for increasing the conductor and conduit sizing when aluminum conductors are substituted for copper. The ampacity of the aluminum conductor shall be equal to or greater than that of the copper conductor specified. The conduit fill shall not exceed NEC requirements.

B. Conductors No. 10 AWG and smaller shall be solid and conductors No. 8 AWG and larger shall be stranded. Minimum wire size shall be #12 unless otherwise noted on the drawings.

C. All wire and cable shall be permanently marked approximately every two feet to indicate size, voltage and type temperature rating in accordance with NEC Article 310.11.

D. Provide factory colored insulation for conductors for No. 10 and smaller. Color code larger insulated conductors with an approved field applied tape.

E. Copper conductors shall be as follows:

1. Type THHN or THWN: For dry and wet locations; maximum operating temperature shall be 75°C (THWN) or 90°C (THHN). UL listed as gasoline and oil resistant. PVC insulation with nylon outer jacket. Meet UL 83 and Federal Spec J-C-30B.

2. Type XHHW: For wet or dry locations; maximum operating temperature 90°C. insulation shall be cross-linked polyethylene complying with UL 44 for XHHW-2.

F. Aluminum conductors shall be as follows:

1. Type XHHW-2: For dry and wet locations, maximum operating temperature 90°C. The conductor shall be compact stranded AA-8000 series aluminum with black cross-linked polyethylene insulation. The cable shall meet the requirements of Federal Specification JC-30B. The conductor shall comply with ASTM Standards B800 and B801.

2.3 INSULATED ELECTRICAL SPRING CONNECTORS

A. Provide color coded, electrical spring connectors with a pliable vinyl skirt. The connectors shall be temperature rated 105 degrees Celsius with 600 volt insulation. The connectors shall be U.L. listed and comply with Federal Specification W-S-160.

2.4 COMPRESSION CONNECTORS AND LUGS

A. The connectors shall be copper with tin plating. The connectors and lugs shall be designed to connect to the cable by means of dieless hydraulic compression tool.

2.5 INSULATED POWER DISTRIBUTION BLOCKS

A. The power distribution blocks shall be rated 600 volt, 90 degrees Celsius with tin plated copper connections. The blocks shall be mounted in an insulated base with a removable clear cover. The connector size and configuration shall be as recommended by the manufacturer for the conductors being spliced.

2.6 ALUMINUM CONNECTORS AND TERMINATIONS

A. All connectors and terminations shall be UL listed for use with aluminum conductors. All connectors and terminations shall be comply with UL Standard 486B and be marked "AL7CU" for 75°C circuits of "AL9CU" for 90°C circuits.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mechanically protect conductors for systems by installing in raceways. Do not install the conductors until raceway system is complete and properly cleaned. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Use Ideal Wire Lube Yellow #77 Plus wire pulling lubricant or equal when pulling large conductors. The lubricant shall be compatible with rubber, neoprene, nylon polyvinyl chloride, high density or cross linked polyethylene, low density polyethylene, semiconducting jacket and hypalon cable types. Wiring pulling compound shall be U.L. listed and approved by wiring manufacturer.

C. Pull conductors simultaneously where more than one is being installed in same raceway.

D. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.

E. Contractor may provide conductors with THHN-THWN insulation for general wiring.

F. Contractor shall provide conductors with XHHW insulation where called for on the drawings.

G. Neatly and securely bundle all conductors in enclosures using nylon straps with a locking hub or head on one end and a taper on the other.

3.2 SPLICES AND TERMINATIONS

A. Splices shall be kept to a minimum. Splices shall be made in junction and pull boxes. Splices shall not be made in conduit fittings, switch and circuit breaker enclosures, panelboards, motor starters, motor control centers or switchboards. All connectors shall be of material recommended by conductor manufacturer(s) to prevent any corrosion or electrolysis between dissimilar metals.

B. Use compression type connectors or insulated power distribution blocks for splices of all stranded conductors 6 AWG and larger. Mechanical, split bolt, type connectors for conductor splices are not acceptable.

C. Use ring-tongue type terminators on all control wiring.

D. Use insulated electrical spring connectors for conductors 8 AWG and smaller.

E. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.

3.3 ALUMINUM CONDUCTOR TERMINATIONS

A. All connections and terminations shall be made in accordance with the cable manufacturer’s recommendations. All connections shall have an anti-oxidant compound applied to the conductors.

B. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.

3.4 CONDUCTOR SIZING

A. Conductors shall be provided as required by the more stringent requirements of the drawings or the specifications.

B. Provide No. 10 conductor for single-phase, 120-volt, 20-ampere branch circuits for which the distance from panelboard to the first outlet is more than 100 feet. The entire branch circuit from the overcurrent device to the last outlet shall be No. 10 minimum.

C. Provide No. 10 conductors for single-phase 277 volt, 20 amp circuits for which the distance from panelboard to the first outlet is more than 200 feet. The entire branch circuit from the overcurrent device to the last outlet shall be No. 10 minimum.

3.5 HOMERUNS

A. No more than three phase conductors, neutral and ground shall be installed in a single raceway for all feeders; HVAC and Plumbing equipment such as refrigeration equipment, fan motors, pumps, and compressors; elevators, and other similar types of equipment unless specifically noted on the drawings.

B. Multi-wire branch circuits and individual branch circuits shall be allowed to be combined in a single homerun. The maximum number of circuits shall be six. The contractor shall be responsible to apply the conductor ampacity derating factors and increase the raceway size as required by the NEC.

C. All individual branch circuits shall have a separate neutral conductor and the neutral shall be considered a current carrying conductor.

D. Provide a separate neutral conductor for each receptacle circuit serving isolated ground receptacles. This neutral shall be considered a current carrying conductor.

E. Use home run circuit numbers as indicated for panelboard connections.

F. Comply with ampacity adjustment factors as required by the NEC Article 310.16.

3.6 COLOR CODE

A. All wiring shall be color coded in accordance with Section 26 05 53.

3.7 SIGNAL, COMMUNICATIONS, AND/OR SIMILAR SYSTEMS

A. Special system(s) conductors (i.e., telephone, intercom, P.A., fire alarm system(s), etc.) shall be sized as required and recommended by the system manufacturer.

END OF SECTION

SECTION 26 05 26
GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies the furnishing and installation of grounding and bonding equipment for electrical systems.

B. Extent of electrical grounding and bonding work is as specified herein. Provide a completely grounded system sized in accordance with Article 250 of the NEC Each piece of electrical apparatus shall be solidly grounded with separate insulated green ground wire.

1.2 REFERENCE STANDARDS

A. ANSI/IEEE Std 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

B. ANSI/UL 467 - Safety Standard for Grounding and Bonding Equipment.

1.3 APPLICABLE PROVISIONS

A. Refer to Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Submit manufacturer's product data on grounding and bonding equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the requirements, acceptable manufactures shall be as follows:

1. Adalet PLM Division.
2. Blackhawk Industries.
3. Burndy Corporation.
4. Cadweld Division, Enrico Products Inc.
5. Crouse Hinds Division, Cooper Industries.
6. Copperweld Corporation.

7. Ideal Industries Inc.

8. ITT Blackburn

9. Ilsco.

10. Joslyn Corporation.

11. O. Z. Gedney.

12. Square D.

13. Thomas and Betts Corporation.

2.2 CONNECTIONS

A. Above grade connections shall be by means of bonds and clamps of a malleable iron or cast bronze material which will not cause electrolytic action between the conductor and the connector.

B. Listing. UL 467.

2.3 GROUNDING BUSHINGS

A. Grounding bushings shall be insulated type with a combination lug of correct size for quick positive ground connections. The bushing body shall be malleable iron or steel. The ground lug may be removed during assembly if desired. Each fitting shall be provided with a cup-point set screw for locking the bushing in any desired position.

2.4 BONDING JUMPERS

A. Bonding jumpers shall be flexible tin plated copper braided straps. The minimum circular mil of the braids shall be 77,184 for jumpers rated 200 ampere and less. The minimum circular mil of the braids shall be 303,912 for jumpers rated over 200 amperes and up to 430 amperes.

2.5 GROUND CONDUCTORS

A. Ground conductors shall be as specified in Section 26 05 19.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide bonding jumpers in raceway system around expansion joints. All metallic conduits shall be electrically continuously.

B. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.

C. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

D. Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

3.2 SYSTEM GROUND

A. The system neutral and ground shall be bonded to the grounding electrode conductor in the service entrance switchgear in accordance with NEC 250.28. The system neutral and ground shall not be bonded at any other point in the distribution system except for separately derived systems.

B. Ground all separately derived systems in accordance with NEC 250.30.

C. The system grounding electrode conductor shall be in accordance with NEC 250.66, unless larger sizes are indicated.

3.3 EQUIPMENT GROUND

A. Raceway Systems and Equipment Enclosures.

1. Ground cabinets, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, transformer enclosures, other equipment and metallic enclosures. Ground equipment and enclosures to the continuous-grounded, metallic raceway system in addition to any other specific grounding shown.

2. Provide bonding jumpers and ground wire throughout to ensure electrical continuity of the grounding system. Bonding jumpers shall be sized in accordance with NEC 250.66.

3. Provide an equipment grounding conductor in each branch circuit and each feeder.

B. Grounding conductors shall be sized in accordance with NEC 250.122 unless larger sizes are indicated.

C. Bonding equipment jumpers shall be sized in accordance with NEC 250.66 unless larger sizes are indicated.

3.4 GROUNDING BUSHINGS

A. Feeder conduits terminating in switchboards, distribution panels, motor control centers and panelboards shall be provided with grounding bushings. Bushings shall be connected to the

ground bus in the equipment. Connect the equipment grounding conductor to the grounding bushing and the equipment ground bus in the associated switchgear.

3.5 MOTORS

A. Ground each motor by means of a separate grounding conductor in the conduit connection to the motor. Grounding conductors shall be sized in accordance with NEC Table 250.122 and shall be securely and permanently attached to the motor body and to the ground bus in the panelboard, switchboard or motor control center.

3.6 RECEPTACLES

A. All receptacles shall be bonded to their device box. This connection shall be made by means of a bonding jumper between the device and the box. Where the receptacle mounting yokes are designed and listed for the purpose of grounding the bonding jumper may be omitted.

B. All isolated ground receptacles shall have an isolated ground conductor installed complete from receptacle to the isolated ground bus in the associated panelboard.

END OF SECTION

SECTION 26 05 29
METAL FRAMING AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of metal framing, including channels, necessary hangers, fittings, clamps, anchor bolts and rods, hardware, supports, electrical accessories and brackets, for properly installing all electrical equipment and materials.

1.2 REFERENCE STANDARDS

A. NEMA ML 1 - Metal Framing.

B. NFPA 70 - National Electrical Code.

1.3 APPLICABLE PROVISIONS

A. Refer to Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Submit product data for all materials including, but not limited to: pipe straps, beam clamps, metal framing, rod hangers, trapeze hangers, u-bolts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, acceptable manufacturers shall be as follows:

1. Metal Framing.

   (a) American Electric.

   (b) Allied Tube and Conduit.

   (c) B-Line Systems Inc.

   (d) Kindorf, Electrical Products Division.

   (e) Unistrut.

2. Insert Anchors.

   (a) Ackerman-Johnson Fasteners.

(b) American Electric.

(c) Hilti Inc.

(d) Star Expansion Co.

2.2 CHANNEL SYSTEMS

A. Fabricate channels from pre-galvanized stip steel in accordance with ASTM A-446, Grade A requirements. The minimum channel size shall be 1-5/8 inches wide by 1-5/8 inches deep. Provide larger channels as required to suit the particular installation requirements.

B. Fabricate clamping nuts steel bar stock. Channel clamping nuts shall meet the requirements of ASTM A-575, Grade M 1015 and shall be case hardened to 25 HRC. Hex head nuts and bolts shall meet the requirements of ASTM A-563 and ASTM A-307.

C. All nuts and bolts shall meet the requirements of the Unified Screw Threads standard ANSI B1.1, course series UNC, Class 2.

D. All fasteners shall have an electro-galvanized finish.

E. Channel system fittings shall be fabricated from bar or strip steel in accordance with the requirements of ASTM A-36. All fittings shall have an electro-galvanized finish.

F. Channel system clamps shall be fabricated from steel in accordance with the requirements of ASTM A-569. All clamps shall have an electro-galvanized finish.

G. Channel system mounting brackets shall be fabricated from hot rolled steel. All fittings shall have an electro-galvanized finish.

H. Channel system beam clamps shall be fabricated from cold formed steel or cast from malleable iron. All beam clamps shall have an electro-galvanized finish.

2.3 ROD HANGERS

A. Rod hangers shall be selected for weight supported but shall not be smaller than No. 8.

B. Rod hangers and adjustable "J" pipe hangers equal to Kindorf Type C-149 for conduits. Conduits two inches (2") and smaller may be fastened with pipe hangers equal to Kindorf Type 6H.

2.4 MISCELLANEOUS FASTENERS

A. Galvanized U-bolts or Kindorf C-210 riser pipe clamps on channel iron bearing plates at intervals of at least one clamp per joint shall be provided for support of vertical runs of conduits of more than twelve feet (12').

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely fasten and support conduits and raceways of all types and all electrical boxes, devices, and equipment from the main building structure. Conduit system shall not be supported by ceiling hanger wires. Support conduits within three feet (3'-0") of each end, of each bend and each termination. Support conduit runs at ten feet (10'-0") intervals along the run to maintain true raceway alignment without sag or deformation. The use of cadi-clips for conduit supports from suspended ceiling systems is not acceptable.

B. On exposed raceways and cable run without conduit, provide supports at a minimum of six feet (6') on centers and on each side of each bend. Vertical conduits shall be supported at not more than 10' on center in addition to the above.

C. Maintain horizontal and vertical alignment of raceways to not adversely effect the building structure in strength or appearance. Cable, strap, or wire hangers or fasteners shall not be used.

D. Install exposed wall mounted conduits after wall surface is installed. Secure the conduits with anchors that provide adequate space to allow wall to be painted after conduit is installed.

E. Secure cabinets and boxes to the building structure independent of all raceways entering the cabinets and boxes.

F. Angle iron or framing channel supports shall be used to support all panelboards, cabinets, junction and pull boxes.

G. Fasten cabinets, boxes, panelboards, disconnects, motor controls and similar devices indicated other than at walls on channel iron racks mounted to floor and structure above.

H. All boxes shall be rigidly and securely fastened to the structural surface to which they attach. All boxes must be supported from a structural portion of the building independent of the raceway system.

1. Surface mounted boxes shall be fastened by means of wood screws to wood, expansion bolts on concrete, toggle bolts on hollow masonry units and machine screws on metal construction.

2. Exposed boxes shall be supported by means of all-thread rods 1/4" diameter minimum. The all-thread rods shall be secured to the structure.

3. Boxes concealed in walls shall be secured to the wall stud with a minimum of two fasteners. Use wood screws in wood and machine screws in metal. Boxes that attach to metal studs shall be fastened to a second wall stud by means of a backing brace or rod.

4. Boxes recessed in suspended ceilings shall be supported in the same manner as described for exposed boxes or by means of approved bar hangers that attach firmly to the ceiling grid.

5. Boxes embedded in concrete or masonry boxes shall have integral metal ears that embed into the concrete or masonry grout.

6. The methods of support outlined herein are not intended to cover every condition. If conditions other than these occur, the contractor shall propose a method to the engineer for approval prior to installation.

I. Place support and leveling channels for free standing type switchgear, transformers, and motor control equipment.

J. Rust inhibit all supports by galvanizing or other approved means. Supports shall be job rust inhibited at all cuts, breaks, welds, or other points where rust inhibitor coating is broken.

3.2 ANCHOR BOLTS

A. Use ½-inch diameter by 3 inches long expansion bolts to attach framing to concrete. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

3.3 TOUCH-UP

A. Touch up all scratches or cuts on steel components with an approved zinc chromate or a 90% zinc paint.

END OF SECTION

SECTION 26 05 33
RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies the furnishing and installation of raceway systems.

1.2 REFERENCE STANDARDS

A. ANSI/ANSI C80.1 - Specification for Zinc-Coated Rigid Steel Conduit.

B. ANSI/ANSI C80.3 - Specification for Zinc-Coated Electrical Metallic Tubing.

C. ANSI/ANSI C80.4 - Specification for Fittings for Rigid Metal Conduit and Electrical Metallic Tubing.

D. ANSI/UL 1 - Safety Standard for Flexible Metal Conduit.

E. ANSI/UL 5 - Safety Standard for Surface Metal Raceways and Fittings.

F. ANSI/UL 651 - Safety Standard for Rigid Nonmetallic Conduit.

G. ANSI/UL 797 - Electrical Metallic Tubing.

H. ANSI/UL 870 - Safety Standard for Wireways, Auxiliary Gutters and Associated Fittings.

I. NEMA 2.10-2003 - Selection and Installation Guidelines for Fittings for use With Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit and Electrical Metallic Tubing).

J. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80) and Fittings.

K. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

L. UL 6 - Rigid Metal Electrical Conduit.

M. UL 360 - Liquid-tight Flexible Steel Conduit.

N. UL 467 - Electrical Grounding and Bonding Equipment.

O. UL 1242 - Intermediate Metal Conduit.

1.3 APPLICABLE PROVISIONS

A. Refer to Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 HANDLING AND STORAGE

A. Handling shall be done to assure that raceways are not crushed or damaged in any way which would restrict cross sectional area or cause oxidation.

1.5 SUBMITTALS

A. Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide raceway of one of the following manufacturers:

1. Rigid Metal Conduit, Intermediate Metal Conduit and Electrical Metallic Tubing:

(a) Allied Tube & Conduit Corp.

(b) Maverick Tube Corporation/Republic Conduit.

(c) Perma-Cote Industries.

(d) Western Tube and Conduit Corporation.

(e) Wheatland Tube Co.

2. Flexible Metal Conduit, Liquidtight Flexible Metal Conduit:

(a) Alflex Corp.

(b) Anamet Corp.

(c) Electri-Flex Co.

3. Surface Metal Raceways and Wireways:

(a) Wiremold.

(b) Square D.

(c) Thomas & Betts.

4. Conduit Fittings and Bodies:

(a) Appleton.

(b) O.Z. Gedney.

(c) Ocal.

(d) American Electric.

(e) Raco, Inc.

(f) Crouse-Hinds.

(g) Thomas & Betts Corporation.

2.2 CONDUIT AND FITTINGS

A. Rigid Metal Conduit.

1. Hot-dipped galvanized rigid steel conduit per ASTM Standard A-153 galvanized after fabrication. All threads shall be galvanized after cutting. A uniform zinc coating shall applied to the inner and outer walls.

2. Fittings shall be threaded, insulated throat, malleable iron, either cadmium plated or hot-dipped galvanized.

3. Conduit shall be in manufactured accordance with UL Standard 6, ANSI C80.1 and Federal Specification WW-C-581E.

B. Intermediate Metal Conduit.

1. Conduit shall be the same as rigid metal conduit except thinner wall.

2. Fittings shall be threaded, insulated throat, malleable iron, either cadmium plated or hot-dipped galvanized.

3. Conduit shall be manufactured in accordance with UL Standard 1242 and ANSI C80.6.

C. Electrical Metallic Tubing (EMT).

1. Shall be made of strip steel. The exterior shall be hot dipped galvanized with a zinc coating applied over the galvanized coating. The interior shall be coated with a silicone epoxy-ester lubricant.

2. Fittings shall be steel compression type. Fittings for circuits containing conductors 4 AWG and larger shall be the insulated throat type.

3. Conduit shall be manufactured in accordance with UL 797, ANSI C80.3 and Federal Spec. WWC-563.

D. Flexible Metal Conduit

1. Be made of spirally wound continuously interlocked zinc coated strip steel.

2. Fittings shall be malleable iron, squeeze type zinc plated or hot dipped galvanized. Fittings for circuits containing conductors 4 AWG and larger shall be the insulated throat type.

3. Conduit shall be manufactured in accordance with UL Standard 1 and Federal Spec. WW-C-566. Fittings shall be manufactured in accordance with UL Standard 467.

E. Liquid-Tight Flexible Metal Conduit.

1. Be made of spirally wound continuously interlocked zinc coated strip steel with a concentric PVC outer jacket. Conduits 1 1/4" in diameter and smaller shall have a continuous copper ground conductor built into the core. The PVC jacket shall be water and oil resistant, UV stabilized and be suited for installation in ambient temperatures of -20 to +60 degrees Celsius.

2. Fittings shall be compression type, malleable iron, with insulated throat, either cadmium plated or hot-dipped galvanized.

3. Conduit shall be manufactured in accordance with UL Standard 1 and Federal Spec. WW-C-566. Fittings shall be manufactured in accordance with UL Standard 467.

2.3 CONDUIT EXPANSION COUPLINGS

A. Provide Thomas& Betts XJG-TB rigid or intermediate metal conduit expansion couplings or the equivalent.

1. The fitting body shall be constructed from malleable or ductile iron. The conduit body shall be PVC coated fittings when installed in runs of PVC coated conduit.

2. The fitting shall have an internal bonding jumper constructed of a tinned copper braid sized to comply with U.L. fault current requirements and NEC 250.98 bonding requirements.

3. The fitting shall be capable of compensating for a minimum of 4 or 8 inches thermal expansion and contraction. The amount of movement shall be calculated in accordance with the NEC. The fitting shall be rain tight.

2.4 WIREWAYS

A. Provide lay-in wireways with hinged cover, knockouts, connectors and fittings. All screws installed towards the inside shall be protected to prevent possible wire insulation damage. Wireways shall be NEMA 1 when located in dry areas and NEMA 3R when located in wet areas. Wireways shall be constructed from minimum 16 gage sheet metal for sizes 4" x 4" and smaller and 14 gage sheet steel for sizes larger than 4" x 4". NEMA 3R wireway shall have knockouts in the bottom only. Provide with wire retainers not less than 12" on center.

B. The finish shall be ANSI-49 gray epoxy and shall consist of not less than two coats of enamel over a rust-inhibiting prime coat.

C. The wireway shall be manufactured in accordance with UL Standard 870 and all components shall be UL listed.

PART 3 - EXECUTION

3.1 CONDUIT AND FITTINGS

A. The minimum conduit size shall be 3/4 inch except for final connections to individual light fixtures. 1/2 inch flexible metal conduit may be used in lengths up to six foot for final connections to individual light fixtures

B. Types According to Use. Use rigid metal conduit throughout the project except as specified below.

1. Provide rigid metal conduit where exposed to rain, condensation, moisture, constant high humidity or corrosive atmospheres.

2. Electrical metallic tubing may be used for branch circuitry above accessible ceilings and work concealed in walls. Electrical metallic tubing shall not be used in concrete slabs, in crawlspaces, in contact with earth or in areas that are subject to permanent moisture.

3. Intermediate metal conduit may be used in lieu of rigid metal conduit for feeders in interior dry locations.

4. Schedule 40 PVC may be used for buried branch circuits from five feet outside of the building as permitted by the NEC and local codes except where rigid is herein called for. All boxes, fittings, couplings, transition fittings, adhesives and installation procedures recommended by the manufacturer shall be strictly followed. All stub-ups shall transition to rigid steel conduit prior to the elbow.

5. PVC may be used in concrete floor slabs for branch circuitry to floor boxes or free standing equipment only. Feeders shall not be installed in floor slabs. All stub-ups shall transition to rigid steel prior to the elbow. The maximum conduit size allowed in the floor slab shall not exceed 1 1/4" diameter. The number and placement of conduit in the slab shall be in accordance with the requirements of the structural engineer.

6. PVC conduit may be installed in the fill beneath the structural floor slab for conduit sizes larger than 1 1/4" diameter for slab on grade applications. All stub-ups shall transition to rigid steel conduit prior to the elbow.

7. Feeders installed underground may be schedule 40 PVC with concrete encasement in lieu of rigid steel.

8. Flexible and liquid-tight flexible metal conduit shall be used for final connections to utilization equipment. Maximum length shall be three foot. Liquid-tight shall be used for all exterior locations and any interior location subject to moisture. Refer to Section 26 00 00 for further information.

C. Transitions.

1. Continue the heavier, more protective type conduit application not less than 4 inches into the area where lighter, less protective type conduit is permitted.

D. Place sleeves in the forms of walls and floor slabs for the free passage of conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Apply caulking for sleeves through floors and through exterior walls. Install plugs or caps on all conduits prior to concrete placement. Provide sleeves and penetrations in accordance with Section 26 00 00.

E. Installation Requirements.

1. Metallic conduits shall be continuous between enclosures such as outlets, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit shall be secured to enclosures so that the raceway system is electrically continuous throughout. Where threaded conduits enter enclosures provide locknuts on the inside and outside of the enclosure.

2. Where threaded conduits are terminated in enclosures, provide insulated bushings for conductor protection. In equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide an insulated grounding bushing and extend the grounding conductor to the ground bus.

3. All raceways shall be installed perpendicular and parallel to the building lines in a neat and orderly manner.

4. All raceways are to be concealed in all finished areas unless otherwise specifically indicated on the Drawings. When exposed the exact routing shall be confirmed in the field with the Architect/Engineer prior to rough in. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select plates to properly fit the conduit when securely locked in place.

5. Install raceway systems where indicated on the Drawings, complete with all junction boxes and pullboxes as necessary and noted on plans.

F. Installation Methods.

1. All raceway systems shall be complete before installing conductors.

2. All raceways shall have openings temporarily plugged to exclude foreign objects. The interior of all raceways shall be cleaned before pulling installing conductors.

3. All joints shall be cut square and be reamed smooth. All field threaded conduits shall be coated with an approved zinc chromate or with a 90 percent zinc paint.

4. All turns shall be made with standard ells or conduit bent in accordance with the NEC. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1-inch may be used

only where specifically approved by the Architect. Furnish and install access doors for conduit bodies located above inaccessible ceilings. Refer to architectural drawings for required access doors' fire ratings. All field bends shall be made using equipment designed for the particular conduit material and size. Bends shall be free from dents or flattening. There shall be no more than the equivalent of three ninety degree bends in any raceway between terminals and cabinets, or between outlets and junction boxes or pull boxes.

5. Securely fasten and support conduit to metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Refer to Section 26 05 29. Galvanized tie wires for securing conduits, is not acceptable. The use of cadi-clips for conduit supports from suspended ceiling systems is not acceptable.

6. Provide a No. 30 nylon pull cord in all empty conduits. Identify both ends of the line by means of labels or tags reading "Pulling Line".

7. Terminate concealed conduit for future use with a coupling at structural surfaces. Install an approved conduit plug flush with the surface.

8. All openings around electrical penetrations at fire rated walls, partitions, floors or ceilings shall be sealed to maintain the fire resistance rating of the penetration. Refer to Section 26 00 02.

9. All conduit in hazardous areas shall conform to NEC requirements for these areas and where feeding from or to a hazardous area to another room "seal offs" shall be used.

3.2 THERMAL EXPANSION AND CONTRACTION

A. Provide expansion fittings where required to compensate for thermal expansion and contraction in runs of metallic conduit systems as required by the National Electrical Code and the Contract Documents. The full coefficient of thermal expansion and contraction shall be taken into account for in all outdoor locations and all interior locations that are not heated and air conditioned to maintain a fairly constant temperature (+/- 10 degrees F). An expansion fitting shall be provided in any conduit run that is calculated to have 0.20 inches or greater of expansion or contraction. The calculations shall be done in accordance with NEC 300.7.

3.3 SEALING RACEWAYS

A. Seal the interior of all raceways that will be subjected to different temperatures such as penetration through walls between air conditioned and non-air conditioned spaces, walk-in cooler, walk-in freezers and other similar areas to prevent the circulation of air. The sealing compound shall be compatible with the conductor insulation material and be U.L. listed.

3.4 WIREWAYS

A. Install wireways, where shown, according to NEC Article 376. Field apply a 90 percent zinc paint coating over cuts or scratches before any other finish is applied.

3.5 SURFACE RACEWAYS

A. Install surface raceways, where shown, according to NEC Article 386 for metal raceways and 388 for nonmetallic raceways. A cutting tool specifically designed for cutting of the raceway shall be used for all field cuts. All cuts shall be square. Field paint all metal edges left exposed by cutting operations to match the finish of the raceway.

B. Securely ground raceway and fittings.

C. Provide bushings at raceway entrances.

END OF SECTION

SECTION 26 05 33.01
ELECTRICAL BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies the furnishing and installation of all outlet boxes, floor boxes, junction boxes and pull boxes.

1.2 REFERENCE STANDARDS

A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports, and Cast Aluminum Covers.

B. ANSI/UL 514 - Electrical Outlet Boxes and Fittings.

1.3 APPLICABLE PROVISIONS

A. Refer to Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Submit manufacturer's product data on electrical boxes.

1.5 DELIVERY STORAGE AND HANDLING

A. Deliver boxes properly packaged in accordance with Section 26 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, acceptable manufacturers shall be as follows:

1. Appleton.
2. Bowers.
3. Cooper Crouse-Hinds.
4. Hubbell Electrical Products.
5. Hoffman Engineering Company.
6. Midwest Electric Products, Inc.

7. O.Z. Gedney.

8. Raco Inc.

9. Thomas & Betts

2.2 OUTLET BOXES

A. Provide galvanized steel boxes of sufficient size to accommodate wiring devices to be installed at outlet. Provide an extension ring for the device to be installed. Square or rectangular boxes may be supplied. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Unless otherwise noted, provide 2-1/8-inch deep by 4-inch box.

B. Provide corrosion-resistant cast-metal FS or FD rain tight outlet wiring boxes with threaded hubs for surface mounting in areas having exposed rigid metal conduit systems and all outdoor locations. Provide galvanized boxes for surface mounting in areas having exposed EMT.

C. Boxes for Lighting Fixtures. Provide galvanized steel octagonal boxes with fixture stud supports and attachments as required to properly support ceiling and bracket-type lighting fixtures. Unless otherwise noted, provide 2-1/8-inch deep by 4-inch box.

D. Masonry Boxes. Provide galvanized steel, 3-1/2-inch deep, masonry boxes for all devices installed in masonry walls.

2.3 JUNCTION AND PULLBOXES

A. Junction and Pull Boxes: Provide galvanized code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers. Junction and pull boxes shall be 16 gauge for sizes up to 12' x 12' x 12' and 10 gauges for all sizes 12" x 12" x 12" and larger.

B. Provide NEMA 1 boxes in interior dry locations.

C. Provide NEMA 3R boxes in all exterior locations and interior locations subject to moisture.

PART 3 - EXECUTION

3.1 COORDINATION

A. In order that all outlets may come in proper relation to paneling, decorated areas, etc., this Contractor shall familiarize himself with the details of these spaces and shall carefully lay out all outlets so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause the device or fixtures at or in these outlets to be inaccessible for use or maintenance. This Contractor must consult with the other Contractors on the project and procure all details of the various locations so as to make the outlet boxes come in proper relation to the work of all other trades. The Architect/Engineer

reserves the right to relocate any outlet within reason from its original location shown on the plans prior to the application of the walls at no cost.

3.2 OUTLET BOXES

A. Unless otherwise indicated, mount all outlet boxes flush within 1/4-inch of the finished wall or ceiling line. Provide galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Provide plaster covers for all boxes in plastered walls and ceilings.

B. Boxes for suspended lighting fixtures shall not be attached to or supported from suspended ceilings, unless specifically approved by ceiling installer/manufacturer. Do not support boxes from ceiling grids.

C. Do not connect outlet boxes back to back unless specific approval is obtained. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.

D. Provide only the conduit openings necessary to accommodate the conduits at the individual location. Provide knockout closures to cap all unused openings.

E. Provide weatherproof outlets and outlets in areas subject to moisture with gaskets between the box and the cover plate.

F. All boxes shall be provided with covers.

G. Mounting Height. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall. None of the mounting heights listed in this section are to be construed as waiving of the regulations of any authority having lawful jurisdiction. Verify all device mounting heights with the Architect prior to rough-in. Device mounting heights shall be as follows:

1. Manual Motor Starters +54" AFF

2. Disconnect Switches +54" AFF

3. Fire alarm system visual and audio/visual devices shall be mounted at eighty inches (80") above the highest floor level within the space or six inches (6") below ceiling, whichever is lower.

4. Special system devices such as lighting motion sensors shall be mounted as recommended by the manufacturer's written instructions.

3.3 JUNCTION AND PULL BOXES

A. Install boxes as required to facilitate cable installation in raceway systems. Junction and pull boxes shall be sized to accommodate conductor system splices and associated

insulation. Generally provide boxes in conduit runs of more than 100-feet or as required in Section 26 05 33. Locate boxes strategically and make them of such shape to permit easy pulling of wire or cables. The use of extension rings to increase the junction boxes interior space capacity is not acceptable.

B. Provide boxes so that covers are readily accessible and easily removable after completion of the installation. furnish and install suitable access doors for boxes located above inaccessible ceilings. Select a practical size for each box and cover. All boxes shall cover plates. Refer to architectural drawings for required access doors' fire ratings.

3.4 FIRE ALARM SYSTEM BOXES

A. All junction boxes associated with the fire alarm system shall be painted red. Each box cover plate shall be labeled by zones, refer to Section 26 05 53 for acceptable label type.

END OF SECTION

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to; buried electrical line warnings, identification labeling for raceways, cables, and conductors, operational instruction signs, warning and caution signs, equipment labels and signs.

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code

B. ANSI - American National Standards Institute

C. OSHA - Occupational Safety and Hazard Association

1.3 APPLICABLE PROVISIONS

A. Section 26 00 00 - Electrical General Provisions

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Submit manufacturer's product data for all electrical identification materials.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Ideal Industries, Inc.
2. LEM Products, Inc.
3. Panduit Corp.
4. Seton Name Plate Co.
5. Thomas & Betts Corp.
6. W.H. Brady, Co.

2.2 ADHESIVE TAPE

A. Colored Adhesive Marking Tape for Wires, and Cables shall be self-adhesive vinyl tape not less than 7 mils thick by 3/4 inch wide. Color shall be as required by the color code table. The tape shall be Scotch #35 or equal.

2.3 PLASTIC LAMINATE SIGNS

A. Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes.

B. Engraved legend in white letters on black face and punched for mechanical fasteners.

2.4 CABLE TIES

A. Cable Ties shall be self-locking nylon cable ties, 3/16-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 40 degree F to 225 degree F. T & B Ty-wrap or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

B. Where identification is to be applied to surfaces that require a finish, install identification after completion of finish work.

3.2 SWITCHGEAR

A. Existing Panelboards.

1. Identify the panelboard designation and voltage characteristics.

2. Prepare a neatly typed revised circuit directory behind clear heat-resistant plastic for each existing panelboard. Identify circuits by equipment served and by room numbers. The room names and numbers shall be verified with the Architect. Indicate spares and spaces with light, erasable pencil marking. Identify the panelboard with an engraved plastic laminate sign.

3.3 MISCELLANEOUS ELECTRICAL EQUIPMENT

A. Identify all power receptacles where the nominal voltage between any pair of contacts is greater than 150 volts with circuit number, voltage and phases. The information shall be contained on the face plate. The device cover plate shall be labeled with the “E-Z Coder” wire marker printer system by Thomas & Betts or equal. The label material shall be white self adhesive vinyl cloth that is oil, water and humidity resistant. The minimum size of the label material shall .5" wide by .5" high. Provide other sizes of label material as required for the particular applications so that the printing is clearly legible.

B. Provide engraved nameplates for all switches controlling equipment which is not in sight of the control switch. The nameplate shall identify the equipment served.

3.4 JUNCTION AND PULLBOXES

A. Junction and pullboxes shall be labeled with the “E-Z Coder” wire marker printer system by Thomas & Betts or equal. The label material shall be white self adhesive vinyl cloth that is oil, water and humidity resistant. The size of the label material shall 1.5" wide by .5" high. shall be labeled with the “E-Z Coder” wire marker printer system by Thomas & Betts or equal. The label material shall be white self adhesive vinyl cloth that is oil, water and humidity resistant. The size of the label material shall 1.5" wide by .5" high.

B. Label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plastic tags at concealed boxes.

3.5 CONDUCTOR COLOR CODE

A. Provide color coding for the conductors of each feeder, and branch circuit. The conductor color coding shall be in accordance with the local authority having jurisdiction in cases where local code requirements differ from the requirements listed in the color code table. The color code shall match the existing system's color coding.

B. Furnish and install conductors with color factory-applied the entire length of the conductors except as follows:

1. Furnish and install conductors with factory applied color the entire length of the conductor, for all conductors that are 10 AWG and smaller.

2. For conductors larger than 10 AWG, apply colored pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 3/4-inch-wide tape in colors as specified. Do not cover cable identification markings by taping. Tape locations may be adjusted slightly to prevent such covering.

3.6 NAMEPLATES.

A. Apply equipment identification labels of engraved plastic- laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with ½-inch high lettering on 1-inch high label (1-1/2-inch high where two lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Verify the exact terminology with the A/E.

Lettering Height	
1/2"	Panelboards, electrical cabinets, and enclosures.
1/2"	Access doors and panels for concealed electrical items.

1/4" Motor starters.
1/2" Pushbutton motor control stations.
1/4" Contactors.
1/5" Switch remote from equipment controlled.
1/4" Disconnect switches.

B. Install nameplates labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. Nameplate shall be secured to equipment by means of self tapping machine screws.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies the furnishing and installation of wiring devices, occupancy sensors and device cover plates.

B. Install the occupancy sensors, power packs and control wiring in accordance with the recommendations of the manufacturer.

1.2 REFERENCE STANDARDS

A. ANSI/UL 20 - General-Use Snap Switches.

B. ANSI/UL498 - Electrical Attachment Plugs and Receptacles.

C. UL 943 - Ground Fault Circuit Interrupters.

D. NEMA WD 1 - General-Purpose Wiring Devices.

1.3 APPLICABLE PROVISIONS

A. Refer to Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Submit manufacturer's product data on wiring devices.

1.5 DELIVERY STORAGE AND HANDLING

A. Deliver wiring devices properly packaged in accordance with Section 26 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, acceptable manufacturers shall be as follows:

1. Wiring Devices

(a) Arrow Hart, Division Crouse-Hinds.

(b) Hubbell Inc., Wiring Device Division

(c) Leviton Manufacturing Co.

(d) Pass & Seymour Inc.

2.2 GROUND FAULT CIRCUIT INTERRUPTERS

A. Provide feed through type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of protecting connected downstream receptacles on single circuit, and of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20-amperes, 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; with NEMA configuration 5-20R. The receptacles shall be Hubbell GF5362 heavy duty industrial or equal.

B. The device shall trip if the line or load connections are miswired.

2.3 DEVICE COVER PLATES

A. Device cover plates in finished spaces shall be impact resistant nylon thermoplastic. Device plate shall be provided with positive bow to assure that all four edges of the plate are flush against the wall. All cover plates shall be provided with captive screws.

B. Device cover plates in weatherproof locations shall meet UL 514 for continuous use in a wet location. The cover plates shall be Taymac #20510, deep cover, vertical mount.

C. Device cover plates in exposed dry interior spaces shall be heavy duty cadmium-plated sheet steel. Edges of plate must be flush with edges of boxes.

PART 3 - EXECUTION

3.1 GENERAL

A. Where items of equipment are provided under other sections of this specification or by the Owner, provide a compatible receptacle for the cap or plug and cord of the equipment.

B. Multiple gang cover plates shall be used for all multiple device locations.

C. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the Contractor to paint, patch, etc. around the opening to the satisfaction of the Architect/Engineer.

D. Tighten connectors and terminals securely, including screws and bolts.

E. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.

F. Install cover plates after painting work is completed, tight to surfaces over which they are installed.

3.2 RECEPTACLES

A. Mount receptacles vertically centered at the height specified.

3.3 DEVICE COVERPLATES

A. Provide device cover plates for each device of the type required for service and device involved.

END OF SECTION

SECTION 26 28 13
OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies the furnishing and installation of low voltage fuses rated 600 volts and below, 6000 amperes and below and automatic circuit breakers.

1.2 REFERENCE STANDARDS

A. ANSI/ANSI C97.1 - Standard for Low Voltage Cartridge Fuses 600 Volts and Less.

B. ANSI/UL 198.2 - High-Interrupting-Capacity Current-Limiting Fuses.

C. NEMA FU 1 - Low Voltage Cartridge Fuses.

D. NEMA AB 1 - Molded Case Circuit Breakers.

E. NEMA AB 2 - Procedures for Verifying the Performance of Molded Case Circuit Breakers.

F. UL 198.4 - Class R Fuses.

1.3 APPLICABLE PROVISIONS

A. Refer to Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Submit shop drawings and product data for fuses and circuit breakers.

B. Include time current curves, dimensions, voltage, short circuit ampere interrupting rating, continuous current rating and number of poles.

1.5 OPERATION AND MAINTENANCE DATA

A. Provide operation and maintenance data in accordance with Section 26 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, acceptable manufacturers shall be as follows:

1. Circuit Breakers.

(a) General Electric Co.

(b) Cutler Hammer.

(c) Siemens Energy and Automation Inc.

(d) Square D Co.

2.2 MOLDED CASE CIRCUIT BREAKERS

A. Provide molded-case thermal magnetic circuit breakers. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole. Two and three pole breakers shall be common trip. Construct with over center, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Construct breakers for mounting and operating in any physical position and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated for 65° or 75°C wire for breaker sizes less than 100 amperes and 75°C for breaker sizes 100 amperes and greater. The circuit breakers shall have a minimum 10,000 AIC at 120/208 volts and 14,000 AIC at 277/480 volt. Provide breakers with an AIC rating equal to or greater than the minimum rating noted on the panelboard schedules.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install overcurrent protective devices for all wiring and equipment as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

3.2 CIRCUIT BREAKERS

A. Fasten circuit breakers without mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cabling.

B. Set field-adjustable circuit breakers for trip settings as indicated, subsequent to installation of units.

C. Inspect circuit-breakers operating mechanisms for malfunctioning and, where necessary, adjust or replace units for free mechanical movement.

END OF SECTION

SECTION 26 28 16
ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of enclosed switches.

B. Provide enclosed switches as the disconnecting means for equipment.

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code.

B. UL 98 - Safety Standard for Enclosed Switches.

C. NEMA KS 1 - Enclosed Switches.

1.3 APPLICABLE PROVISIONS

A. Section 26 00 00 - Electrical General Provisions.

B. Section 01 81 13 – Sustainable Construction Requirements

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product data on enclosed switches. Submittals shall include the following:

1. Voltage, Phase, Horsepower/Ampere Rating

2. NEMA Enclosure Type

3. Dimensions

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, acceptable manufacturers shall be as follows.

1. Cutler Hammer.

2. General Electric Co.

3. Siemens Energy and Automation Inc.

4. Square D Co.

2.2 CHARACTERISTICS

A. Provide switches with voltage rating of 240 volts or 600 volts a-c, as required to match the distribution system voltage.

B. Provide heavy duty switches conforming to NEMA KS 1 standard for Type HD switches.

C. Provide switches with quick-make, quick-break contacts.

D. Unless otherwise indicated, provide 3-pole, visible blade switches.

2.3 CONSTRUCTION

A. Switches shall be furnished in NEMA 1 general purpose enclosures in interior dry locations and NEMA 3R enclosures in exterior locations and indoor areas subject to moisture. Covers on NEMA 1 enclosures shall be attached with pin type hinges. NEMA 3R covers shall be securable in the open position. Enclosures shall be manufactured from galvanized steel. Enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatized steel.

B. The operating handle shall be suitable for padlocking in the OFF position with as many as three padlocks of 5/16-inch diameter shank. The switch cover shall be interlocked with the operating mechanism to prevent opening the cover when the switch is in the ON position and to prevent turning the switch ON when the door is open.

C. The lugs shall be front accessible, UL listed for 65 or 75 degree C, aluminum or copper wires.

D. Provide incoming line terminals with an insulated shield so that live parts are not exposed when the door is open.

E. Provide switches with isolated, fully rated neutral block in circuits with a neutral conductors.

F. Provide each switch with a ground lug for termination of the circuit grounding conductors.

G. Provide fused switches with rejection-type fuse holders which are suitable for use with fuses specified.

H. Provide factory nameplate, front cover mounted, indicating the switch type, catalog number and voltage, amperage and horsepower ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide switches for all equipment as required to comply with NEC requirements for equipment disconnecting means.

B. Mount the switches so that the operating handle is approximately 54 inches above finished floor. Where switches are group mounted, align the tops of all of the switches.

3.2 DISCONNECT SWITCHES MARKING

A. All disconnect switches shall be labeled as required by Section 26 05 53.

3.3 GROUNDING

A. Connect the equipment ground conductor to the grounding lug in the enclosed switches.

END OF SECTION