

Wilmington ATCT DDC & Base Building HVAC Upgrade

Wilmington International Airport, NC

for the

**US Department of Transportation
Federal Aviation Administration**

Design Specifications

**Burns & McDonnell Engineering Co., Inc.
Atlanta, Georgia
March 2022**

BMCD Project Number: 135297



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BURNS & McDONNELL

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SECTION 01 00 00 – GENERAL PARAGRAPHS

PART 1 - GENERAL

1.1 DRAWINGS, SPECIFICATIONS, AND OTHER CONTRACT DOCUMENTS

- A. Drawings showing general outlines and details necessary for a comprehensive understanding of the work form a part of the Contract Documents. The total number and the titles of the drawings constituting the Drawings are given in the index of the Drawings. All work under the Contract must be performed in all respects in compliance with the requirements of the Contract Documents.
- B. The Contract Documents provide for a complete work and may have been prepared in divisions of various crafts, trades and other categories of work. The Contractor is responsible for the performance of all work under the Contract regardless of any such divisions and must ensure that all of the work is performed and completed.
- C. The FAA will provide the Contractor with one bound copy of the construction drawings and specifications for the Contractor's use during the execution of the Contract. The Contractor may reproduce these documents for its use during the performance of the work under this Contract.
- D. The Contractor must maintain at the Site at all times at least one (1) copy of Drawings, Specifications, and all other Contract Documents, together with at least one (1) complete set of approved Shop Drawings and approved samples.
- E. The Contractor must make available at the job site one copy of each referenced standard (or as directed by the COR, for the Contractor's and the FAA's use during the time that work is covered by the standard.
- F. The Contract, Drawings, Specifications, and all referenced standards cited are essential parts of the Contract requirements. A requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work.
- G. On the drawings, calculated or figured dimensions govern over scaled dimensions.
- H. In the event of a conflict between commercially available or industry standard documents and specific requirements in FAA Orders and Notices, the more stringent shall apply.
- I. The Contractor must not take advantage of any apparent error, omission, discrepancy, or ambiguity on the Drawings or Specifications. If any error, omission, discrepancy, or ambiguity is found by the Contractor in the Drawings or Specifications, the Contractor must refer the same to the Contracting Officer (CO) prior to beginning work on affected task(s), for interpretation and decision, and such decision must be final.
- J. The CO has the right to correct apparent errors or omissions in the Drawings and Specifications

and to make such interpretations as he may deem necessary for the proper fulfillment of the Contract Documents. During the course of the work, should any conflicts, ambiguities, or discrepancies be found that are not addressed or any discrepancies between the Drawings and the Specifications to which the Contractor has failed to call attention before submitting the offer, then the CO will interpret the intent of the Drawings and Specifications and the Contractor hereby agrees to abide by the CO's interpretation and agrees to carry out the work in accordance with the decision of the CO. In such event the Contractor will be held to have included in the offer the most proper material and/or method of construction in order to fulfill the intent of the Contract Documents.

- K. When a material, article, or equipment is designated by a brand name, and more than one brand name is listed, it will be understood that the design is based on one of the brand name listed products. The Contractor will be responsible for all coordination necessary to accommodate the material, article, or equipment actually being provided without additional cost to the government.
- L. The organization of the specification into divisions, sections and articles, and the arrangement of Drawings does not restrict or limit the Contractor in dividing the Work among Subcontractors or in establishing the extent of work to be performed by any trade.
- M. Product and Reference Standards:
 - 1. When descriptive catalog designations including manufacturer's name, product brand name, or model number are referred to in the Contract Documents, such designations are considered as being those found in industry publications of current issue on the date of the first advertisement for offers.
 - 2. When standards of the Federal Government, State Department of Transportation, Standards Organization such as ASTM, AASHTO, AWS, or ANSI, trade societies, or trade associations are referred in the Contract Documents by specific date of issue, these are considered a part of this Contract. When such references do not bear a date of issue, the current published edition on the date of the first advertisement for offers are considered as part of the Contract.
 - 3. Where in the Contract Documents an item is identified by a particular manufacturer's name, model or other code it must be interpreted to include other manufacturers' product of like and equal quality whether the words "or equal" are included or not unless specifically stated otherwise.
 - 4. Wherever a particular manufacturer's product is required, to the exclusion of all others, appropriate language is included in the Contract Documents.
 - 5. Wherever the terms, "as directed", "ordered", "permitted", "designate", "as approved", "approved equal", "or equal", "acceptable" and other words of similar meaning which authorize an exercise of judgement are used in the Contract Documents, such judgment is vested only in the CO or designated representative.
 - 6. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1.2 CONFORMITY WITH DRAWINGS AND SPECIFICATIONS

- A. No deviation from the Drawings, Specifications and other Contract Documents will be permitted without the prior written approval of the CO.

1.3 SUPERVISION AND CONSTRUCTION PROCEDURES

- A. At all times during performance of this contract, and until the work is completed and accepted, the Contractor must directly superintend the work or assign and have on the worksite a competent superintendent who is an employee of the Contractor and is satisfactory to the CO and has the authority to act for the Contractor.
- B. The Contractor must supervise and direct the Work, using the Contractor's best skill and attention. The Contractor is solely responsible for and has control over construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the Work under the Contract including coordination of the duties of all trades, unless the Contract Documents give other specific instructions concerning these matters.
- C. The Contractor must control its operations and those of its Subcontractors and Suppliers to assure the least inconvenience to the traveling public. Under all circumstances, safety must be the most important consideration.
- D. Contractor must lay out all work well enough in advance to avoid conflicts or interferences with other work in progress so that in case of interference the layout may be altered to suit the conditions, prior to the installation of any work and without additional cost to the FAA. The Contractor must be responsible to coordinate all work and take all action as required to avoid conflicts between trades.

1.4 CORRESPONDENCE

- A. Contract correspondence must be directed to the CO with a copy to the Contracting Officer's Representative (COR). Send submittals directly to the COR with a copy of the transmittal letter to the CO.

1.5 LIST OF SUBCONTRACTORS

- A. The Contractor must, within 10 calendar days after award, furnish to the CO with a copy to the COR, a list of subcontractors showing the type of work each will perform. If all subcontracts have not been awarded when the initial list is submitted, the Contractor must update the list monthly.

1.6 WORK NOT INCLUDED

- A. Items noted on the drawings, details, or schedules as "N.I.C." (Not in Contract) are not included in this contract.

B. FAA Furnished Insurance

1. FAA is not maintaining any insurance on behalf of Contractor covering against loss or damage to the Work or to any other property of Contractor. In the event Contractor maintains insurance against physical loss or damage to Contractor's construction equipment and tools, such insurance must include an insurer's waiver of rights of subrogation in favor of FAA.

1.7 SECURITY REQUIREMENTS FOR FIBER OPTICS (FOTS) AND DEMOLITION

- A. Personnel List: Contractor must provide the COR with a list of Contractor's personnel who will require access to the site. The list must be kept current during project work. The Contractor must provide all personnel with readily identifiable numbered badges during the period their access to the site is required. Badges must be in accordance with Airport Requirements and must be worn on outer clothes at all times when on airport property and at work in the site.
- B. Communication: The Contractor must request through the COR, a meeting with the Airport Manager and Control Tower personnel to discuss planned Contractor activities in the controlled airport operation area.
- C. Right to Search: Current procedures at FAA facilities located within airport boundaries include the "right to search". If in the judgment of the authorized security guard, or COR, a cause to search a vehicle or the person of personnel exists, such search will be made.
- D. Airport Requirements: Contractor must also meet all the Airport's security requirements for work at the airport. Pay all fees associated with airport requirements.

1.8 EXISTING WORK

- A. The disassembling, disconnecting, cutting, removal, or altering in any way of existing work must be carried on in such a manner as to prevent injury or damage to all portions of existing work, whether they are to remain in place, be re-used in the new work, or be salvaged and stored.
- B. All portions of existing work which have been cut, damaged, or altered in any way during construction operations must be repaired or replaced in kind in an approved manner to match existing or adjoining work. All work of this nature must be performed by the Contractor at his expense and must be as directed. Existing work must, at the completion of all operations, be left in a condition as good as existed before the new work started.

1.9 MATERIALS AND EQUIPMENT TO BE SALVAGED

- A. Except where specifically specified otherwise herein, or designated on the drawings, all existing materials and equipment which are required to be removed or disconnected to perform the work but are not indicated or specified for use in the new work, becomes the property of the Contractor and must be disposed of properly.

1.10 PARTIAL OCCUPANCY OR USE

- A. The FAA may occupy or use any completed or partially completed portion of the Work at any stage and, if the FAA chooses such partial occupancy, the Contractor and FAA must designate by an agreement the conditions of such partial occupancy. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the FAA and Contractor have accepted in writing the responsibilities assigned to each of them by the COR for payments, retainage if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. Consent of the Contractor to partial occupancy or use by the FAA must not be unreasonably withheld.

1.11 UNCOVERING AND CORRECTION OF WORK

A. Uncovering Work

- 1. If any portion of the Work is covered contrary to the COR's request or to requirements specifically expressed in the Contract Documents, it must, if required in writing by the COR be uncovered for his observation and be recovered (if corrections are not required) or be corrected, if applicable, at the Contractor's expense without change in the Contract Time.

B. Correction Of Work

- 1. The Contractor must promptly correct Work rejected by the COR that fails to conform to the requirements of the Contract Documents, whether observed before or after Substantial Completion and whether or not fabricated, installed or completed. The Contractor must bear all costs of correcting such rejected Work, including additional testing and inspections and compensation for the COR's services and expenses incurred by the FAA.
- 2. If, within two years after the date of Substantial Completion of the Work or designated portion thereof, or after the date for commencement of warranties established above, or by terms of an applicable special warranty required by the Contract Documents, any of the work is found to be not in accordance with the requirements of the Contract Documents, the Contractor must correct it promptly after receipt of written notice from the FAA to do so unless the FAA has previously given the Contractor a written acceptance of that specific condition. This period of two years must be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual performance of the Work. This obligation survives acceptance of the Work under the Contract and termination of the Contract. The FAA must give such notice within a reasonable amount of time after discovery of the condition.
- 3. The Contractor must remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the FAA.
- 4. If the Contractor fails to correct nonconforming Work within a reasonable time, the FAA may correct it in accordance with General Provisions. If the Contractor does not proceed with correction of such nonconforming Work within a reasonable time fixed by written notice from the COR, the FAA may correct or remove such nonconforming work and all

costs for such corrections or removals must be assessed against the Contractor.

5. The Contractor must bear the cost of correcting destroyed or damaged Work, whether completed or partially completed, of the FAA or separate contractors caused by the Contractor's performing correction or removal of Work which is not in accordance with the requirements of the Contract Documents.
6. Nothing contained herein shall be construed to establish a period of limitation with respect to other obligations that the Contractor might have under the Contract Documents. Establishment of the time period of two years as described above relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability and damages with respect to the Contractor's obligations other than specifically to correct the Work.

1.12 UNDERGROUND UTILITIES

- A. Utilities Encountered - Efforts have been taken to locate all the underground utilities and cables on the contract drawings; however, unforeseen utilities and underground cables may be encountered. Actual cable locations must be verified in the field by the Contractor by hand digging a minimum of five (5') on each side of the cable. FAA owned cable will be marked by the FAA prior to the start of work by the Contractor.

1.13 LOCATION OF SERVICES

- A. The FAA does not guarantee the accuracy or the completeness of the location information relating to existing utility services, facilities, or structures that may be shown on the drawings. Any inaccuracy or omission in such information must not relieve Contractor of its responsibility to protect such existing features from damage or unscheduled interruption of service.

1.14 COOPERATE WITH OTHER ENTITIES

- A. Cooperate with the FAA and other public or private utility services, or a utility service of another government agency that may be authorized by the FAA to construct, reconstruct, or maintain such utility services or facilities during the progress of the work. Control operations to prevent the unscheduled interruption of such utility services and facilities.

1.15 NOTICE TO FAA/OPERATORS

- A. Prior to commencing the work in the general vicinity of an existing utility service or facility, Contractor must notify each FAA/operator in writing of activities that might affect its interests. If, in Contractor's opinion, the FAA/operator's assistance is needed to locate the utility service or facility or the presence of a representative of the FAA/operator is desirable to observe the work, such advice should be included in the notification. Furnish a copy of such written notices to COR.

1.16 EXCAVATION METHODS

- A. Where the outside limits of an underground utility service have been located and staked on the ground, Contractor must use excavation methods acceptable to the COR as may be required to insure protection from damage due to Contractor's operations.

1.17 DAMAGE TO SERVICES

- A. Should Contractor damage or interrupt the operation of a utility service or facility by accident or otherwise, it must immediately notify in writing the FAA/operator, appropriate public safety authorities, and the COR and must take all reasonable measures to prevent further damage or interruption of service. Cooperate with the utility service or facility FAA and the COR continuously until such damage has been repaired and service restored.

1.18 FAILURE TO PROTECT PROPERTY

- A. Contractor will not be entitled to any extension of time or compensation on account of Contractor's failure to protect all facilities, equipment, materials and other property as described herein. All costs in connection with any Improvements or restoration necessary or required by reason of unauthorized obstruction, damage, or use must be borne by Contractor.

1.19 UTILITY CONTRACTOR LICENSING REQUIREMENTS

- A. Contractor must comply with all state and local requirements for construction of utilities.

1.20 ASBESTOS AND LEAD FREE CERTIFICATION

- A. FAA policy is to construct all new facilities without asbestos or lead containing products. The Contractor must provide a letter on his company's standard letter head stating that to the best of his knowledge no product or material used on this project contains asbestos or lead. The statement must include the name of the project and the contract number and must be signed by an officer of the company. The statement must be furnished within 10 calendar days of the Substantial Completion date. Submission of this statement is a condition for final payment under the contract.
- B. Verification: If the FAA suspects the presence of asbestos or lead, tests will be performed on the material or product at the FAA's expense. If it is determined that the product or material does contain asbestos or lead, then the Contractor must remove the product or material and replace at his own expense including the expense of the testing and any retesting that may be necessary.
- C. Non – Compliance: If the Contractor fails to provide the above statement, then the FAA may have a complete building survey performed by a qualified testing firm and the costs deducted from the Contractor's final payment.

1.21 MATERIAL SAFETY DATA SHEETS (MSDS):

- A. The Contractor must submit to the COR Material Safety Data Sheets (MSDS) for all materials and/or products utilized during the course of the project accomplishment. During the course of the project, both the COR and the Contractor must routinely check products utilized on-site to ensure only products which have had MSDS submitted are utilized. Copies of all MSDS must be turned over to the local FAA office for their records.

1.22 INITIAL SUBMITTALS

- A. The following submittals are required to have FAA approval prior to Notice to Proceed.

1.	Section 01 00 00	LIST OF SUBS, CERTIFICATE OF INSURANCE
2.	Section 01 32 00.20	CONTRACTOR-PREPARED CONSTRUCTION SCHEDULE
3.	Section 01 40 00	CONTRACTOR QUALITY CONTROL
4.	Section 01 52 16	SAFETY PLANS

1.23 KNOWLEDGE SHARING NETWORK (KSN) SITE

The FAA maintains a joint use internet site for the purpose of electronic communication with the Contractor. It is a requirement to use this KSN site for submittals, RFI's and other communications with the government. The government will provide access and required passwords to allow access to this site.

1.24 1.24 UTILITY CONTACTS

NOT USED.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 00 00

SECTION 01 10 00 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

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

1.2 DEFINITIONS

- A. Contracting Officer's Representative (COR): Individual authorized to receive and distribute information on the behalf of the Contracting Officer. Also referred to as the Contracting Officer's Technical Representative (COTR) and/or Resident Engineer (RE) in some instances.
- B. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.
- C. Recycled Content: The percentage by weight of constituents that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer).
1. Spills and scraps from the original manufacturing process that are combined with other constituents after a minimal amount of reprocessing for use in further production of the same product are not recycled materials.

2. Discarded materials from one manufacturing process that are used as constituents in another manufacturing process are pre-consumer recycled materials.

1.3 ENVIRONMENTAL GOALS

- A. Support implementation goals of federal policy and programs for sustainable building, in accordance with Executive Order 13423 – Strengthening Federal Environmental, Energy, and Transportation Management.
- B. Comply with Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings.
 1. Employ Integrated Design Principles.
 - a. Integrated Design.
 - b. Commissioning.
 2. Optimize Energy Performance
 - a. Energy Efficiency.
 - b. Measurement and Verification.
 3. Protect and Conserve Water.
 - a. Indoor Water (conservation)
 - b. Outdoor Water
 4. Enhance Indoor Environmental Quality
 - a. Ventilation and Thermal Comfort.
 - b. Moisture Control.
 - c. Daylighting.
 - d. Low-Emitting Materials.
 - e. Protect Indoor Air Quality during Construction.
 5. Reduce Environmental Impact of Materials.
 - a. Recycled Content.
 - b. Biobased Content.
 - c. Construction Waste.
 - d. Ozone Depleting Compounds.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: ILM Airport Air Traffic Control Tower and TRACON Base Building: Replacement of the HVAC System in the TRACON Base Building and replacement of the HVAC Control System in the Control Tower.

- B. FAA's Lead Project Engineer: **FAA Designer (FAA Routing Code, i.e. AJW-2E11D) FAA Mailing Address.** (TBD)
- C. CO (Contracting Officer): **CO Name, Mailing Address.** (TBD)
- D. The Work consists of the construction of the following:
 - 1. TRACON Base Building New HVAC System
 - 2. Replacement of HVAC System Controls for Airport Traffic Control Tower.

1.5 TYPE OF CONTRACT

- A. Project will be constructed under a firm fixed price contract awarded to a single contractor.

1.6 WORK PHASES

- A. The Work shall be conducted in one phase. The Contractor will be responsible for determining the sequence of operation to maintain security of the airport and the construction site.
- B. Before commencing Work, submit a schedule showing the sequence, commencement and completion dates, and move-in dates of FAA's personnel for all of the Work.
- C. Construction Work stages shall be defined by the Contractor. **The following sequence is only for the main construction site and does not consider work on the airport. It is provided as General Information Only.** Portions of Stages may be simultaneous.

Stage Action

- 1. Remove ceiling tiles in TRACON Building.
- 2. Demolish existing HVAC system and equipment in TRACON Building.
- 3. Install new HVAC system and equipment in TRACON Building.
- 4. Shutdown and Demo existing HVAC control components in ATCT.
- 5. Install and Commission new HVAC Controls in ATCT.

1.7 WORK UNDER OTHER CONTRACTS

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

1.8 USE OF PREMISES

- A. General: Contractor shall have full use of premises for construction operations, including use of Project site, during construction period. Contractor's use of premises is limited only by FAA's right to perform work or to retain other contractors on portions of Project.

- B. Use of Site: Limit use of premises to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1.9 FAA'S OCCUPANCY REQUIREMENTS

- A. FAA Occupancy of Completed Areas of Construction: FAA reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.
 - 1. Subparagraphs below describe procedures and requirements necessary before partial occupancy of portions of Project.
 - 2. COR will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before FAA occupancy.
 - 3. Before partial FAA occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, FAA will operate mechanical and electrical systems serving occupied portions of building. Contractor shall provide maintenance for one year after date of Substantial Completion.
 - 4. On occupancy, FAA will assume responsibility for custodial service for occupied portions of building. Contractor shall provide maintenance for one year after date of Substantial Completion.

1.10 WORK RESTRICTIONS

- A. Normal working hours are 0700 to 1600, Monday through Friday (except U.S. Federal holidays). Contractor requests to work outside normal working hours require COR approval. However, the COR has full discretion to approve or disapprove, or withdraw approval of requests. If the contractor desires to work outside normal hours (including Saturdays, Sundays, and holidays), he shall submit his written request to the COR at least 48 hours in advance. Some typical constraints on working outside normal working hours are:
 - 1. The Contractor's request must be made at least two days in advance (e.g., request received by close of business Wednesday for work on following Saturday). Prior to submitting the request, the Contractor must coordinate as needed (such as utility outages) and have all required people and materials for the work that will be performed.
 - 2. A Contractor with quality or safety problems (as determined by the COR) will be restricted to normal working hours. Contractors may also not work time outside of normal working hours if they are not present on the job site during normal working hours.
 - 3. A Contractor who fails to correct deficiencies within a reasonable time (as determined by the COR) will be restricted to normal working hours or may be allowed to work outside normal working hours only to correct those deficiencies.
 - 4. The Contractor shall schedule his work to cause the least amount of interference to normal activities.
- B. Airport Work: This project will require work in the Airport Operations Area (AOA). Hours of this work must be coordinated by the Contractor with the FAA and Airport Authority. Those hours may be limited to night or other hours not shown above. The Contractor acknowledges

responsibility for badges and fees for all workers and vehicles requiring access to the AOA. The construction schedule and cost proposal must account for any lead time and fees required to obtain necessary badges and permits.

- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by FAA or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by FAA or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated: Notify FAA COR not less than 10 days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without FAA and utility company written permission.
- D. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor air intake
- E. Limits on Operations: The FAA has established moratorium dates for construction activity at critical facilities including the ILM Airport. The intent is to minimize the possibility of any activity that may have an adverse impact on the ability of FAA to perform its operational activities. Moratorium dates may change without notice. The moratorium dates are generally:

September 10 thru 12

November – Friday before Thanksgiving through Monday after Thanksgiving

December/January – Friday before Christmas through Monday after New Years

All construction activity during moratorium periods must be approved in advance by the FAA. Submit items of work to be performed during moratorium dates no later than forty-five (45) days prior to the moratorium dates. Activities that have, in the sole opinion of the FAA, potential to negatively impact FAA operations will not be approved. A written waiver will be provided by FAA to the Contractor outlining the allowable work items. No additional time or cost will be allowed for such denial.

1.11 SPECIFICATION FORMATS AND MISCELLANEOUS PROVISIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 50-division format and CSI/CSC's "MasterFormat" numbering system.
 - 1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in these Specifications are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
 - 2. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

1.12 PERMITS AND FEES

- A. Contractor is responsible for applying for utility services, obtaining required permits, and payment for any associated fees. Compliance is required with the conditions of all permits that have been issued. All fees must be paid by the Contractor.
- B. Contractor is responsible for paying all charges associated with the construction of the project. This includes temporary and permanent utilities, permits, inspection fees, connection fees and equipment to be installed by utility companies. This allocation of financial responsibility applies to all utilities as well as City and County agencies and entities.
- C. Listed below are the agencies that govern this project. Unless otherwise noted, Contractor is responsible for applying for utility services, obtaining required permits, and payment for any associated fees. Compliance is required with the conditions of all permits that have been issued. Additional permits may need to be obtained by the Contractor and all fees must be paid by the Contractor.
- D. BUILDING PERMIT APPLICATIONS
- E. CERTIFICATE OF OCCUPANCY

1.13 INSURANCE

- A. Insurance Requirements

The Contractor shall at its sole expense, procure and maintain in effect at all times during the performance of the Work insurance coverage with insurers and under forms of policies satisfactory to the FAA, and with limits not less than those set forth in the contract.

The contractor shall not commence work until he/she has obtained, and the Contracting Officer has approved, all insurance required within the contract, nor shall the contractor allow any subcontractor(s) to commence work on a subcontract until all similar insurance required of the subcontractor has been obtained and approved. The successful contractor shall be required to procure and maintain bodily injury, general liability, and property damage liability insurance in his/her own name as protection against damages to persons or property, including injury or death, which may result from his/her performance of the work.

The insurance required shall be written for not less than the limits of liability specified in the contract documents, or required by law, whichever is greater. The proof of insurance shall be furnished within ten (10) days from the date of the Notice of Award to the Contracting Officer for approval.

The insurance limits shall be maintained during the entire performance or contract work. No cancellations of any insurance, whether by the insurer or by the insured, shall be effective unless written notice thereof is given to the Contracting Officer at least thirty (30) days prior to the intended effective date thereof, which date has been expressed in the notice. Prior to the effective date of any such cancellation, the contractor shall take out new insurance to cover the policies so canceled. All insurance policies referred to shall be underwritten by companies authorized to do business in the state of construction. The Certification shall be an "ACCORD" certificate with the Contract number and job location identified.

Workmen's Compensation Insurance

This contract shall be void and of no effect unless the contractor secures compensation for the benefit of (and keep insured during the life of this contract) such employees as are required to be insured by the Workmen's Compensation Insurance Law in the state of construction. The contractor hereby agrees to secure such compensation in the manner prescribed by law. The contractor shall require any subcontractors similarly to provide Workmen's Compensation Insurance for all the latter's employees to be engaged in the work unless such employees are covered by the protection afforded by the contractor's Workmen's Compensation Insurance.

The above-indicated insurance shall be maintained during the entire performance of contract work. No cancellation of any insurance, whether by the insurer or by the insured, shall be effective unless written notice thereof is given to the Contracting Officer at least thirty (30) days prior to the intended effective date thereof, which date has been expressed in the notice. Prior to the effective date of any such cancellation, the contractor shall take out new insurance to cover the policies so canceled. All insurance policies referred to shall be underwritten by companies authorized to do business in the state of construction.

B. FAA Furnished Insurance

1. FAA is not maintaining any insurance on behalf of Contractor covering against loss or damage to the Work or to any other property of Contractor. In the event Contractor maintains insurance against physical loss or damage to Contractor's construction equipment and tools, such insurance shall include an insurer's waiver of rights of subrogation in favor of FAA.

C. Notifications

1. In accordance with the submittal requirements outlined above, Contractor shall deliver the original and two (2) copies of the Certificate(s) of Insurance required by this clause

and all subsequent notices of cancellation, termination and alteration of such policies to the CO with a copy to the COR.

D. Certificate of Insurance

1. The scope of coverage shall be shown on the certificate of insurance as "All operations of the Named Insured".

1.14 SECURITY REQUIREMENTS

- A. Personnel List: Contractor shall provide the Resident Engineer with a list of Contractor's personnel who will require access to the site. The list shall be kept current during project work. The Contractor shall provide all personnel with readily identifiable numbered badges during the period their access to the site is required. Badges shall be worn on outer clothes at all times when on airport property and at work in the site.
- B. Security Investigation: Contractor's site superintendent shall submit to an FAA security background check and obtain an official FAA contractor ID badge. Other Contractor personnel may be subject to security investigation by FAA. Upon request by the Contracting Officer's Representative, the Contractor shall promptly complete all security forms provided by FAA.
- C. Communication: The Contractor shall request through the COR, a meeting with the Airport Manager and Control Tower personnel to discuss planned Contractor activities in the controlled airport operation area.
- D. Airport Requirements: Contractor must also meet all the Airport's security requirements for work at the airport. FAA will not provide escorts, communication, or transportation.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 10 00

SECTION 01 10 12 - CONSTRUCTION ADMINISTRATION FORMS

PART 1 – GENERAL

1.1 REQUIREMENTS INCLUDED

- A. The following listed forms are hereby made a part of the Construction Documents.

PART 2 – NOT USED

2.1 INDEX OF CONSTRUCTION ADMINISTRATION FORMS:

- RFI Standard Form
- Submittal Approval Form
- FAA Life Safety System Inspection and Test Report
- Job Memorandum (JM)
- Hot Work Permit
- Lock Out/Tag Out Procedure (See Division 26)

PART 3 - EXECUTION

- A. During the administration of the Contract, the Contractor will be required to complete various construction administration forms as a part of the Management System. These forms are identified above and will be issued at the Pre-Construction Conference. These forms may be revised during the construction period and the Contractor will be required to comply with any such revisions.

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Federal Aviation Administration

Request For Information No. 000

Title: _____

From:	Project:	To:
Contractor	JOB TITLE	
Contractor address	Job Location	
Contract:		
Phone:		Phone:
Fax:		Fax:
Contact:		RE:
Drawing or Spec:	Date Started:	Priority: Normal
	Date Required:	Potential Cost Impact? ☐ Yes ☐ No
Attachments? No	Date Completed:	Potential Schedule Impact? ☐ Yes ☐ No
		If yes to either, explain below.

Question (Include Potential Impacts):

Response:

By: _____, FAA

Date:

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APPROVAL OR DISAPPROVAL OF CONTRACTOR'S MATERIALS OR SHOP DRAWINGS				DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION			
1. TO: Contractor Address Tel: Fax: ATTN:				2. DATE CONTRACTOR'S SUBMITTAL RECEIVED:		3. DATE SUBMITTAL RETURNED:	
				4. GOV'T TRANS. NO.		5. CONTRACTOR'S TRANS. NO.	
				6. PROJECT NAME			
				7. CONTRACT NUMBER			
8. TRANSMITTAL REFERENCE TO CONTRACT DRAWINGS and/or SHOP DRAWINGS							
9. TRANSMITTAL REFERENCE TO CONTRACT DRAWINGS AND PARAGRAPH NUMBER and/or CHANGE ORDER NUMBER							
10. FACTS: Gentlemen: We are returning herewith the following Submittal Data:							
A. ITEM NO.	B. NO. COPIES	C. NAME OF SUPPLIER	D. TYPE OF MATERIAL OR EQUIPMENT	E. APPROVAL		F.	
				AS SUBMITTED	AS NOTED*	NOT APPROVED †	REVISE AND RESUBMIT
				☐	☐	☐	☐
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G. REMARKS							
H. STIPULATIONS							
*Data marked "Approved as Noted" is satisfactory, contingent upon contractor acceptance of corrections and/or notations, and if accepted does not require re-submittal.							
†Data marked "Not Approved" does not meet job requirements, and contractor must re-submit on proper basis.							
Approval of Data does not obviate Contractor Responsibility for correct take-off or installation clearance.							
Carbon Copies Transmitted To:				Sincerely,			
				Resident Engineer			

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FAA Life Safety System Inspection & Test Report

PART 1 FIRE SYSTEM LOCATION, NOTIFICATION OF TEST & VISUAL INSPECTION

PROTECTED PROPERTY:

PERSON RESPONSIBLE: _____ TITLE: _____
PHONE: _____ FAX: _____

Check each box that applies to the fire system being tested.

☐ STANDARD ATCT	☐ PROPERTY FAA OWNED
☐ NON-STANDARD ATCT	☐ PROPERTY FAA LEASED
☐ SMO	☐ ARSR SITE
☐ SSC	☐ SITE OCCUPIED
☐ AFSS	☐ SITE UNOCCUPIED
OTHER _____	

NOTIFICATION PRIOR TO FIRE SYSTEM TESTING:

Notify the following Individuals and/or Office of the fire system test.

☐ FIRE DEPARTMENT	☐ CENTRAL STATION	☐ BUILDING OCCUPANTS
☐ A. F. MANAGER	☐ SMO SAFETY OFFICER	☐ REGION SAFETY MANAGER
☐ TERMINAL MANAGEMENT	☐ AIR TRAFFIC MANGER	☐ AIRPORT MANAGEMENT
OTHER _____		

VISUAL INSPECTION OF SYSTEM PRIOR TO TESTING:

Visually inspect the following Prior to Testing.

☐ CONTROL PANEL(S)	☐ PANEL LIGHTS	☐ PULL STATIONS
☐ PANEL SWITCHES	☐ SYSTEM BATTERIES	☐ POWER SUPPLIES
☐ PRESSURIZATION FAN(S)	☐ LOAD VOLTAGE	☐ SMOKE DETECTORS
☐ BATTERY CHARGER TEST	☐ HVAC SYSTEM(S)	☐ STROBES
☐ ELEVATOR EQUIPMENT	☐ AUDIO DEVICES	☐ REMOTE ANNUNCIATOR
☐ DACT	☐ SUPPRESSION SYSTEM(S)	☐ PRINTER
☐ REMOTE DETECTOR INDICATOR	☐ SYSTEM RECORDS	☐ RECORD DRAWINGS
☐ SYSTEM MODIFICATIONS	☐ EMERGENCY GEN.	☐ OPERATORS MANUAL
OTHER _____		

Make notations below in the comment section for items which are deficient and noted during the visual inspection.
Additional space is available for notation of deficiencies in each section below.

WARNING:

IF THIS SYSTEM PROVIDES DETECTION AND/OR CONTROL FOR AUTOMATIC SUPPRESSION, THE AGENT RELEASE PORTION OF THE SUPPRESSION SYSTEM(S) *MUST* BE *DISABLED* PRIOR TO TESTING ANY SYSTEM INITIATING DEVICES TO PREVENT INADVERTENT AGENT RELEASE!

THIS FACILITIES HVAC SHUTDOWN, ELEVATOR RECALL AND PRESSURIZATION FAN SYSTEMS MUST BE TESTED ANNUALLY, TO INSURE PROPER OPERATION. AVOID UNNECESSARY CYCLING OF THESE SYSTEMS AND DISABLE THE CONTROLLING RELAYS OR ACTIVATE THE PREPROGRAMMED BY-PASS SWITCH AFTER INITIAL TESTING AND VERIFICATION OF EACH.

FAA Life Safety System Inspection & Test Report

PART 2

FIRE SYSTEM PANEL DATA & SERVICE INFORMATION

LOCATION OF THE FIRE ALARM PANEL/FIRE COMMAND CENTER:

SYSTEM MANUFACTURER _____

MODEL NO.: _____

DATE SYS. COMMISSIONED: _____

SERVICE COMPANY: _____

PHONE: _____

FAX: _____

ADDRESS: _____

CONTACT: _____

SERVICE CONTRACT: ☐ YES ☐ NO

NICET CERT. NO.: _____

NICET LEVEL: _____

STATE LICENSE NO.: _____

DATE SERVICE STARTED: _____

DATE SERVICE DEFAULTS: _____

DATE OF LAST SYSTEM SERVICE: _____

DATE OF LAST SYSTEM TEST: _____

DOES THE PANEL APPEAR TO BE OPERATING PROPERLY (NORMAL CONDITION) ☐ YES ☐ NO

IS THE FIRE PANEL A POWER LIMITED SYSTEM ☐ YES ☐ NO

ARE ALL CIRCUITS SUPERVISED ☐ YES ☐ NO

IS A SYSTEM SMOKE DETECTOR PROVIDED TO PROTECT THE PANEL ☐ YES ☐ NO

IS ADEQUATE BATTERY BACK-UP PROVIDED AS PER NFPA 72 ☐ YES ☐ NO

IS SURGE SUPPRESSION PROVIDED AT THE AC CIRCUIT BREAKER ☐ YES ☐ NO

IS THE 110 VOLT CIRCUIT PERMANENTLY LABELED "FIRE ALARM" ☐ YES ☐ NO

IS AN EMERGENCY GENERATOR PROVIDING BACK-UP POWER ☐ YES ☐ NO

IS THERE MORE THAN ONE SYSTEM PANEL INSTALLED ☐ YES ☐ NO

PANEL POWER SUPPLY, PRIMARY (MAIN), NOMINAL VOLTAGE _____, AMPS _____

OVERCURRENT PROTECTION, TYPE _____, AMPS _____, LOCATION _____

POWER DISCONNECT MEANS _____, LOCATION _____, LOCKOUT _____

SECONDARY (STANDBY) POWER _____ STORAGE BATTERY, AMP-HOUR RATING _____

CALCULATED CAPACITY TO OPERATE SYSTEM, IN HOURS: 4 _____ 24 _____ 60 _____

BATTERY TYPE:

☐ DRY CELL ☐ NICKEL CADMIUM ☐ SEALED LEAD ACID ☐ LEAD ACID ☐ OTHER _____

ENGINE GENERATOR DEDICATED TO THE FIRE ALARM SYSTEM POWER CIRCUIT ☐ YES ☐ NO

TRANSIENT SUPPRESSION:

120V CIRCUIT DEVICE TYPE: _____

QTY. _____

LOCATION: _____

INITIATION CIRCUIT TYPE: _____

QTY. _____

LOCATION: _____

AUDIO CIRCUIT TYPE: _____

QTY. _____

LOCATION: _____

VISUAL CIRCUIT TYPE: _____

QTY. _____

LOCATION: _____

SIGNALING LINE CIRCUIT TYPE: _____

QTY. _____

LOCATION: _____

OTHER: _____

A transient suppression device (listed for operation with the system) is required for each circuit that exits or enters a building. The device shall be mounted in a junction box at the point of exit and entry. Label each circuit being protected.

PART 1 AND 2 DEFICIENCIES NOTED AND/OR COMMENTS:

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

PART 3 **DIGITAL ALARM COMMUNICATOR & MONITORING COMPANY**

☐ YES ☐ NO
☐ YES ☐ NO

FAA Life Safety System Inspection & Test Report

IS THE SPRINKLER OR SUPPRESSION SYSTEM (IF EXISTING) MONITORED: ☐ YES ☐ NO
IS THE DACT A FOUR CHANNEL, DUAL LINE DACT (REQUIRED FOR SPRINKLER) ☐ YES ☐ NO
IS THE DACT POWER FROM THE CONTROL PANEL ☐ YES ☐ NO
IS THE POWER SUPERVISED ☐ YES ☐ NO
IS THERE A DEDICATED PRIMARY PHONE LINE ☐ YES ☐ NO
IS THERE A SECONDARY PHONE LINE ☐ YES ☐ NO
DACT MANUFACTURER: _____ MODEL NO.: _____
NAME OF CENTRAL STATION: _____ POINT OF CONTACT: _____
ADDRESS: _____

ACCOUNT # _____ PHONE: _____ FAX: _____
DATE CONTRACT STARTED: _____ DATE CONTRACT DEFAULTS: _____
LIST NAME AND PHONE NO. OF EACH PERSON(S) TO BE CONTACTED BY THE CENTRAL STATION: _____

NOTED DACT DEFICIENCIES AND/OR COMMENTS:

NOTE: The comment portions of this form are required to have an entry. If a deficiency does not exist then the Technician shall enter "A deficiency has not been noted."

PART 4 INITIATION DEVICES AND INITIATING, OR SIGNALING CIRCUIT TYPE

Initiating devices, are those system(s) devices which *initiate* an alarm or supervisory condition. An Initiating Device Circuit (IDC) is a *hard-wired* (non-addressable) circuit(s), which employees initiating (non-addressable) devices, to send an alarm condition to the fire panel. A Signaling Line Circuit (SLC) is a circuit(s) which employees *addressable* initiating devices (for the purpose of this section). A fire system configuration may consist of both *hard-wired* and *addressable* circuits. Additional information is available to complete this section, in the NFPA 72, Section 23.5 and 12.3 for IDC hardwired circuits and Section 23.6 and 12.3 for SLC addressable signaling line circuits. Check those boxes below that apply to the initiating devices and circuits. PART 6 of this report is for panel to panel communications and/or LCD/Printer communications. In filling out the device chart below wire class should be either "Class A", "Class B", or "Class X".

ADDRESSABLE SYSTEM, SIGNALING LINE CIRCUIT (SLC):

☐ ADDRESSABLE ☐ (CLASS A) ☐ (CLASS B) ☐ (CLASS X)

TOTAL QTY. OF ADDRESSABLE CIRCUITS _____ EACH CIRCUIT CAPACITY (MAX) _____
QTY. OF SPARE ADDRESSABLE POINTS _____ ON CIRCUIT(S) _____
PANEL CAPACITY FOR ADDITIONAL MODULES _____

ADDRESSABLE SYSTEM SOFTWARE:

REVISION NUMBER: _____ REVISION DATE: _____

FAA Life Safety System Inspection & Test Report

ALARM INITIATING, SUPERVISORY & CONTROL DEVICE INFORMATION:

Information of the fire alarm Circuits, Class and Style is noted below. For additional guidance regarding the characteristics of each circuit noted, refer to 12.3 and 23.6 for SLC in NFPA 72.

SYSTEM POINT OR DEVICE TYPE	QUANTITY OF DEVICE TYPE:	WIRE CLASS: (A, B, or X)	CIRCUIT NUMBER:

ADDRESSABLE SYSTEM:

MANUAL STATIONS	_____	_____	_____
IONIZATION DETECTORS	_____	_____	_____
PHOTOELECTRIC DETECTORS	_____	_____	_____
ION DUCT DETECTORS	_____	_____	_____
PHOTO DUCT DETECTORS	_____	_____	_____
FIXED TEMP HEAT DETECTORS	_____	_____	_____
R OF R HEAT DETECTORS	_____	_____	_____
RATE COMPENSATED DETECTORS	_____	_____	_____
MONITOR OR CONTROL MODULE FOR:	_____	_____	_____
FIXED TEMP HEAT DETECTOR	_____	_____	_____
BEAM DETECTORS	_____	_____	_____
UV/IR DETECTORS	_____	_____	_____
COMBINATION DETECTOR	_____	_____	_____
WATERFLOW ALARM SWITCH	_____	_____	_____
WATER SUPERVISORY SWITCH	_____	_____	_____
POST INDICATOR VALVE	_____	_____	_____
WATER SYSTEM AIR PRESSURE	_____	_____	_____
SUPPRESSION PANEL ALARM	_____	_____	_____
SUPPRESSION PANEL TROUBLE	_____	_____	_____
SUPPRESSION PANEL RELEASE	_____	_____	_____
SUPPRESSION PRESSURE SWITCH	_____	_____	_____
SUPPRESSION SUPERVISORY	_____	_____	_____
SECURITY CONTACT	_____	_____	_____
STAIRWELL PRESSURIZATION FAN ON	_____	_____	_____
STAIRWELL PRESSURIZATION FAN OFF	_____	_____	_____
STAIRWELL PRESSURIZATION MANUAL	_____	_____	_____
EMERGENCY GENERATOR ON	_____	_____	_____
EMERGENCY GENERATOR OFF	_____	_____	_____
ELEVATOR RECALL (PRIMARY)	_____	_____	_____
ELEVATOR RECALL (SECONDARY)	_____	_____	_____
FIRE PUMP POWER	_____	_____	_____
FIRE PUMP TROUBLE	_____	_____	_____
FIRE PUMP AUTO.	_____	_____	_____
FIRE PUMP RUNNING	_____	_____	_____
FIRE PUMP OFF	_____	_____	_____
FIRE PUMP PHASE REFFERSAL	_____	_____	_____
OTHER ALARM _____	_____	_____	_____
OTHER TROUBLE _____	_____	_____	_____
OTHER SUPERVISORY _____	_____	_____	_____
OTHER _____	_____	_____	_____

HARDWIRED SYSTEM, INITIATING DEVICE AND SUPERVISORY CIRCUIT (IDC):

☐ HARDWIRED ☐ CLASS A ☐ CLASS B
 TOTAL QTY. OF HARDWIRED CIRCUITS _____ QTY. OF SPARE CIRCUITS _____
 PANEL CAPACITY FOR ADDITIONAL ZONE MODULES _____

FAA Life Safety System Inspection & Test Report

ALARM INITIATING & SUPERVISORY DEVICE INFORMATION:

Information of the fire alarm Circuits, Class and Style is noted below. For additional guidance regarding the characteristics of each circuit noted, refer to 12.3 and 23.5 for IDC in NFPA 72.

SYSTEM POINT OR DEVICE TYPE TYPE:	QUANTITY OF DEVICE (A or B)	WIRE CLASS: (Letter)	CIRCUIT OR ZONE
HARDWIRED SYSTEM:			
MANUAL STATIONS	_____	_____	_____
IONIZATION DETECTORS	_____	_____	_____
PHOTOELECTRIC DETECTORS	_____	_____	_____
ION DUCT DETECTORS	_____	_____	_____
PHOTO DUCT DETECTORS	_____	_____	_____
FIXED TEMP HEAT DETECTORS	_____	_____	_____
R OF R HEAT DETECTORS	_____	_____	_____
RATE COMPENSATED DETECTORS	_____	_____	_____
FIXED TEMP HEAT DETECTOR	_____	_____	_____
BEAM DETECTORS	_____	_____	_____
UV/IR DETECTORS	_____	_____	_____
COMBINATION DETECTOR	_____	_____	_____
WATERFLOW ALARM SWITCH	_____	_____	_____
WATER SUPERVISORY SWITCH	_____	_____	_____
POST INDICATOR VALVE	_____	_____	_____
WATER SYSTEM AIR PRESSURE	_____	_____	_____
SUPPRESSION PANEL ALARM	_____	_____	_____
SUPPRESSION PANEL TROUBLE	_____	_____	_____
SUPPRESSION PANEL RELEASE	_____	_____	_____
SUPPRESSION PRESSURE SWITCH	_____	_____	_____
SUPPRESSION SUPERVISORY	_____	_____	_____
SECURITY CONTACT	_____	_____	_____
STAIRWELL PRESSURIZATION FAN ON	_____	_____	_____
STAIRWELL PRESSURIZATION FAN OFF	_____	_____	_____
STAIRWELL PRESSURIZATION MANUAL	_____	_____	_____
EMERGENCY GENERATOR ON	_____	_____	_____
EMERGENCY GENERATOR OFF	_____	_____	_____
ELEVATOR RECALL (PRIMARY)	_____	_____	_____
ELEVATOR RECALL (SECONDARY)	_____	_____	_____
FIRE PUMP POWER	_____	_____	_____
FIRE PUMP TROUBLE	_____	_____	_____
FIRE PUMP AUTO	_____	_____	_____
FIRE PUMP RUNNING	_____	_____	_____
FIRE PUMP OFF	_____	_____	_____
FIRE PUMP PHASE REVERSAL	_____	_____	_____
OTHER ALARM _____	_____	_____	_____
OTHER TROUBLE _____	_____	_____	_____
OTHER SUPERVISORY _____	_____	_____	_____
OTHER _____	_____	_____	_____

NOTED SIGNALING DEVICE CIRCUIT (SLC), INITIATING DEVICE CIRCUIT (IDC) AND INITIATING DEVICE OR SUPERVISORY DEVICE DEFICIENCIES AND COMMENTS:

[illegible]

PART 5 **NOTIFICATION APPLIANCE CIRCUIT (NAC)**

1. ANSI S3.41, *American National Standard Audible Emergency Evacuation Signal*, which requires that the fire alarm signals be *distinctive* in sound from other signals and not to be used for any other purpose. See NFPA 72, 18.4.2

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2. The use of the three-pulse temporal pattern fire alarm evacuation signal has been adopted by both the American National Standard, ANSI S3.41 (as referenced above) and International Standard, ISO 8201, *Audible Emergency Evacuation Signal*. Information regarding performance, location, and mounting of Notification Appliance(s) is available in NFPA 72, Chapter 6. For control and power supplies refer to Chapter 1 and Chapter 3.

VISUAL STROBE DEVICES:

Strobes shall be UL *labeled* and the label shall indicate compliance with UL 1971, *Signaling Applications for the Hearing Impaired*. Further details are available in the NFPA 72, Chapter 18.4, regarding strobe flash rate and intensity. Spacing information, for strobe placement in room, is available in the NFPA 72 Paragraph 18.5.4, Tables 18.5.4.3.1(a), 18.5.4.3.1(b), and Figures 18.5.4.3.1. Spacing information for strobe placement in corridors is available in Chapter 18.5.4.4.

STROBE CIRCUIT NUMBER	STROBE CIRCUIT CLASS: (A or B)	IS CIRCUIT SUPERVISED AS REQUIRED PER NFPA 72:	QTY. OF STROBES PER CIRCUIT:	POWER (AMPS) REQUIRED TO DRIVE CIRCUIT:
# 1	_____	_____	_____	_____
# 2	_____	_____	_____	_____
# 3	_____	_____	_____	_____
# 4	_____	_____	_____	_____
# 5	_____	_____	_____	_____
# 6	_____	_____	_____	_____
# 7	_____	_____	_____	_____
# 8	_____	_____	_____	_____
# 9	_____	_____	_____	_____
# 10	_____	_____	_____	_____
# 11	_____	_____	_____	_____
# 12	_____	_____	_____	_____
# 13	_____	_____	_____	_____
# 14	_____	_____	_____	_____
# 15	_____	_____	_____	_____
# 16	_____	_____	_____	_____
# 17	_____	_____	_____	_____
# 18	_____	_____	_____	_____
# 19	_____	_____	_____	_____
# 20	_____	_____	_____	_____
# 21	_____	_____	_____	_____
# 22	_____	_____	_____	_____
# 23	_____	_____	_____	_____
# 24	_____	_____	_____	_____
# 25	_____	_____	_____	_____
# 26	_____	_____	_____	_____
# 27	_____	_____	_____	_____
# 28	_____	_____	_____	_____
# 29	_____	_____	_____	_____
# 30	_____	_____	_____	_____

TOTAL POWER (IN AMPS) CONSUMED BY THE VISUAL CIRCUIT(S) _____
 POWER (IN AMPS) AVAILABLE AT THE CONTROL PANEL FOR THE CIRCUIT(S) _____
 IS ADEQUATE BATTERY BACK-UP PROVIDED FOR THE CIRCUITS LISTED _____
 ARE THE CIRCUITS LISTED POWERED BY ONE FIRE CONTROL PANEL _____
 ARE ADDITIONAL PANELS EMPLOYED TO PROVIDE CIRCUIT POWER _____
 ARE THE ADDITIONAL PANELS SUPERVISED BY THE MAIN PANEL _____
 ARE THE ADDITIONAL PANELS PROTECTED WITH A SYSTEM DETECTOR _____
 ARE THE ADDITIONAL PANELS EQUIPPED WITH BATTERY BACK-UP _____
 IS ADEQUATE BATTERY BACK-UP PROVIDED FOR THE PANELS _____

_____	☐ YES	☐ NO
_____	☐ YES	☐ NO
_____	☐ YES	☐ NO
_____	☐ YES	☐ NO
_____	☐ YES	☐ NO
_____	☐ YES	☐ NO
_____	☐ YES	☐ NO
_____	☐ YES	☐ NO

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For areas of general occupancy, Audible signals shall have a sound level of not less than 75 dBA at a distance of 10 feet from the audio device. The sound level of the audio device shall be 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of at least 60 seconds (whichever is greater), measured 5 feet from above the floor in the occupiable area. The sound level of an audio device shall not exceed 110 dBA. Refer to NFPA 72, Chapter 18.4.8 for audio device location.

AUDIO CIRCUIT NUMBER	AUDIO CIRCUIT CLASS: (A or B)	IS CIRCUIT SUPERVISED AS REQUIRED PER NFPA 72:	QTY. OF DEVICES PER CIRCUIT:	POWER (AMPS) REQUIRED TO DRIVE CIRCUIT:
# 1	_____	_____	_____	_____
# 2	_____	_____	_____	_____
# 3	_____	_____	_____	_____
# 4	_____	_____	_____	_____
# 5	_____	_____	_____	_____
# 6	_____	_____	_____	_____
# 7	_____	_____	_____	_____
# 8	_____	_____	_____	_____
# 9	_____	_____	_____	_____
# 10	_____	_____	_____	_____
# 11	_____	_____	_____	_____
# 12	_____	_____	_____	_____
# 13	_____	_____	_____	_____
# 14	_____	_____	_____	_____
# 15	_____	_____	_____	_____
# 16	_____	_____	_____	_____
# 17	_____	_____	_____	_____
# 18	_____	_____	_____	_____
# 19	_____	_____	_____	_____
# 20	_____	_____	_____	_____
# 21	_____	_____	_____	_____
# 22	_____	_____	_____	_____
# 23	_____	_____	_____	_____
# 24	_____	_____	_____	_____
# 25	_____	_____	_____	_____
# 26	_____	_____	_____	_____
# 27	_____	_____	_____	_____
# 28	_____	_____	_____	_____
# 29	_____	_____	_____	_____
# 30	_____	_____	_____	_____

TOTAL POWER (IN AMPS) CONSUMED BY THE AUDIO CIRCUIT(S) _____

POWER (IN AMPS) AVAILABLE AT THE CONTROL PANEL FOR THE CIRCUIT(S) _____

IS ADEQUATE BATTERY BACK-UP PROVIDED FOR THE CIRCUITS LISTED

☐ YES ☐ NO

ARE THE CIRCUITS LISTED POWERED BY ONE FIRE CONTROL PANEL

☐ YES ☐ NO

ARE ADDITIONAL PANELS EMPLOYED TO PROVIDE CIRCUIT POWER

☐ YES ☐ NO

ARE THE ADDITIONAL PANELS SUPERVISED BY THE MAIN PANEL

☐ YES ☐ NO

ARE THE ADDITIONAL PANELS PROTECTED WITH A SYSTEM DETECTOR

☐ YES ☐ NO

ARE THE ADDITIONAL PANELS EQUIPPED WITH BATTERY BACK-UP

☐ YES ☐ NO

IS ADEQUATE BATTERY BACK-UP PROVIDED FOR THE THOSE PANELS

☐ YES ☐ NO

ADDITIONAL PANELS EQUIPPED WITH SURGE SUPPRESSION

☐ YES ☐ NO

ARE AUDIO DEVICES INSTALLED THROUGHOUT THE FACILITY *

☐ YES ☐ NO

ARE AUDIO DEVICES INSTALLED IN ONLY A PORTION OF THE FACILITY

☐ YES ☐ NO

ARE THE AUDIO DEVICES ALL OF THE SAME TYPE (HORN, BELLS, CHIMES, ETC)

☐ YES ☐ NO

ARE THE AUDIO DEVICES COMPLIANT WITH NFPA 72

☐ YES ☐ NO

ARE THERE ANY SPARE AUDIO/VISUAL CIRCUITS AVAILABLE ON THE SYSTEM

☐ YES ☐ NO

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ADDRESSABLE SYSTEM ANNUNCIATORS EQUIPPED WITH ACKNOWLEDGE

☐ YES ☐ NO

NOTED REMOTE ANNUNCIATOR DEFICIENCIES AND COMMENTS:

NOTE: The comment portions of this form are required to have an entry. If a deficiency does not exist then the Technician shall enter "A deficiency has not been noted."

PART 7 **VOICE EVACUATION SYSTEM CONTROLS AND DEVICES**

VOICE EVACUATION SYSTEM CONTROLS:

VOICE PANEL LOCATION: _____

PANEL MANUFACTURER: _____ MODEL NO.: _____

DOES THE PANEL APPEAR TO BE OPERATING PROPERLY (NORMAL CONDITION)

☐ YES ☐ NO

IS THE PANEL EQUIPPED WITH A MIC.

☐ YES ☐ NO

IS THE PANEL EQUIPPED WITH A FIRE PHONE SYSTEM

☐ YES ☐ NO

ARE EXTRA FIRE PHONES AVAILABLE QTY. _____

☐ YES ☐ NO

ARE ALL CIRCUITS SUPERVISED

☐ YES ☐ NO

IS A SYSTEM SMOKE DETECTOR PROTECTING THE PANEL

☐ YES ☐ NO

IS ADEQUATE BATTERY BACK-UP PROVIDED AS PER NFPA 72

☐ YES ☐ NO

IS SURGE SUPPRESSION PROVIDED AT THE 110 VOLT AC CIRCUIT

☐ YES ☐ NO

IS THE 110 VOLT CIRCUIT PERMANENTLY LABELED "FIRE ALARM"

☐ YES ☐ NO

IS THE SYSTEM EQUIPPED WITH BACK-UP AMPLIFIERS

☐ YES ☐ NO

IS THERE MORE THAN ONE VOICE SYSTEM PANEL

☐ YES ☐ NO

IS THE VOICE MESSAGE AUDIBLE

☐ YES ☐ NO

IS THE VOICE MESSAGE APPLICABLE TO THE FACILITIES NEEDS

☐ YES ☐ NO

PANEL POWER SUPPLY, PRIMARY (MAIN), NOMINAL VOLTAGE _____, AMPS _____

OVERCURRENT PROTECTION, TYPE _____, AMPS _____, LOCATION _____

POWER DISCONNECT MEANS _____, LOCATION _____, LOCKOUT _____

SECONDARY (STANDBY) POWER _____ STORAGE BATTERY, AMP-HOUR RATING _____

CALCULATED CAPACITY TO OPERATE SYSTEM, IN HOURS: 4 _____ 24 _____ 60 _____

BATTERY TYPE:

☐ DRY CELL ☐ NICKEL CADMIUM ☐ SEALED LEAD ACID ☐ LEAD ACID ☐ OTHER _____

TRANSIENT SUPPRESSION:

120V CIRCUIT DEVICE TYPE: _____

QTY. _____

LOCATION: _____

AUDIO CIRCUIT TYPE: _____

QTY. _____

LOCATION: _____

Additional information regarding Voice system requirements is available in the NFPA 72, Chapter 24.

VOICE CIRCUIT NUMBER	VOICE CIRCUIT CLASS: (A or B)	IS CIRCUIT SUPERVISED AS REQUIRED PER NFPA 72:	QTY. OF DEVICES PER CIRCUIT:	POWER (WATTS) REQUIRED TO DRIVE CIRCUIT:
# 1	_____	_____	_____	_____
# 2	_____	_____	_____	_____
# 3	_____	_____	_____	_____
# 4	_____	_____	_____	_____
# 5	_____	_____	_____	_____

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# 6	_____	_____	_____	_____
# 7	_____	_____	_____	_____
# 8	_____	_____	_____	_____
# 9	_____	_____	_____	_____
# 10	_____	_____	_____	_____
# 11	_____	_____	_____	_____
# 12	_____	_____	_____	_____
# 13	_____	_____	_____	_____
# 14	_____	_____	_____	_____
# 15	_____	_____	_____	_____
# 16	_____	_____	_____	_____
# 17	_____	_____	_____	_____
# 18	_____	_____	_____	_____
# 19	_____	_____	_____	_____
# 20	_____	_____	_____	_____
# 21	_____	_____	_____	_____
# 22	_____	_____	_____	_____
# 23	_____	_____	_____	_____
# 24	_____	_____	_____	_____
# 25	_____	_____	_____	_____
# 26	_____	_____	_____	_____
# 27	_____	_____	_____	_____
# 28	_____	_____	_____	_____
# 29	_____	_____	_____	_____
# 30	_____	_____	_____	_____

TOTAL POWER (IN WATTS) REQUIRED BY THE AUDIO CIRCUIT(S) _____

POWER (IN WATTS) AVAILABLE AT THE VOICE PANEL FOR THE CIRCUIT(S) _____

IS THE PANEL(S) SUPERVISED BY THE MAIN PANEL

☐ YES ☐ NO

IS ADEQUATE BATTERY BACK-UP PROVIDED FOR THE CIRCUITS LISTED

☐ YES ☐ NO

IS THE PANEL UL CROSS LISTED WITH THE FIRE CONTROL PANEL

☐ YES ☐ NO

IS THE PANEL EQUIPPED WITH MANUAL ZONE SELECTION SWITCHES

☐ YES ☐ NO

ARE ADDITIONAL PANELS EMPLOYED TO PROVIDE CIRCUIT POWER

☐ YES ☐ NO

ARE THE ADDITIONAL PANELS PROTECTED WITH A SYSTEM DETECTOR

☐ YES ☐ NO

ARE THE ADDITIONAL PANELS EQUIPPED WITH BATTERY BACK-UP

☐ YES ☐ NO

IS ADEQUATE BATTERY BACK-UP PROVIDED FOR THE THOSE PANELS

☐ YES ☐ NO

ADDITIONAL PANELS EQUIPPED WITH SURGE SUPPRESSION

☐ YES ☐ NO

ARE AUDIO DEVICES INSTALLED THROUGHOUT THE FACILITY *

☐ YES ☐ NO

ARE AUDIO DEVICES INSTALLED IN ONLY A PORTION OF THE FACILITY

☐ YES ☐ NO

ARE THE AUDIO DEVICES ALL POWER TAPPED THE SAME

☐ YES ☐ NO

ARE THERE ANY SPARE AUDIO CIRCUITS AVAILABLE ON THE SYSTEM

☐ YES ☐ NO

* Note Audio Devices are not to be installed in Tower Cabs, TRACON Rooms, Control Rooms, ETC.

For additional circuits fill out another page 13 of this form and attach.

NOTED AUDIO APPLIANCE AND/OR NOTIFICATION APPLIANCE CIRCUIT DEFICIENCIES AND COMMENTS:

[illegible]**ADDITIONAL NOTATIONS OF THE ANNUAL FIRE SYSTEM INSPECTION AND TEST:**[illegible]

The Annual Inspection and Test of the above noted system(s), at the above noted FAA facility was performed as per the following: FAA ORDER, 6930.1B, Fire Prevention and Maintenance of Fire Protection Equipment, 6470.5A, Maintenance of Air Route Traffic Control Center Environmental Systems, 6480.8A, Maintenance of Airport Traffic Control Towers, 3900.19B, the Occupational Safety and Health Administration, the National Fire Protection Association, the National Fire Alarm Code, and the recommendations of the System Manufacturer. Upon completion this form shall be filed with each individual noted below and the FAA Regional Safety Office.

Updated 12/15/10

FAA Life Safety System Inspection & Test Report

Date: _____ Time: _____ Signature: _____

NICET Cert. #: _____ Printed Name and Title: _____

Employed by: _____ Phone Number: _____

State License or other Credentials: _____

FAA Individual whom witnessed the Fire System returned to normal operation.

Date: _____ Time: _____ Signature: _____

Printed Name and Title: _____

The individuals listed below, with their signatures, affirm that the Fire Life Safety System(s) noted above have been restored to an operational condition. If upon completion of this test an acceptable level of protection is in question, due to the deficiencies noted, then immediate action shall be taken to correct all the deficiencies. A retest of the defective device(s) or system operation(s) shall be required. Appropriate action shall be taken to insure the safety of the facilities individuals and operations during any system repairs and/or service. The responsible FAA Safety Individual shall provide the facilities Manager with Fire Watch training and information if required to insure a continued safe operation during the repairs and service.

By Technician performing the annual test and inspection.

Date: _____ Time: _____ Signature: _____

NICET Cert. #: _____ Printed Name and Title: _____

Employed by: _____ Phone Number: _____

State License or other Credentials: _____

FAA Individual whom witnessed the Fire System returned to normal operation.

Date: _____ Time: _____ Signature: _____

Printed Name and Title: _____

Authority having Jurisdiction and/or approving authority:

Name and Title: _____ Phone: _____ FAX: _____

Representing: _____ Signature: _____

Local Fire Department: _____ Phone: _____ FAX: _____

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U.S. Department
of Transportation
**Federal Aviation
Administration**

ATLANTA TERMINAL ENGINEERING CENTER

P.O. Box 20636
Atlanta, Georgia 30320-0631

-6505

JOB MEMORANDUM (JM)

JM No.: _____ Date: _____ Sheet _____ of _____

To: _____

Project: _____ (B.P. _____)

Field inspection has indicated that the following work is not being performed in accordance with the Contract Documents. The Contractor is requested to provide his proposed Contractor Corrective Action (CCA) no later than _____.

Reference: Sheet No.: _____ Specification No.: _____ Other: _____
Subject: _____

—

Description _____ of _____ Discrepancy:

Resident Engineer _____

CONTRACTOR'S CORRECTIVE ACTION (CCA)

CCA No.: _____ Date: _____

To: **FEDERAL AVIATION ADMINISTRATION – RESIDENT ENGINEER**

The following action has been

taken _____

Contractor _____

FAA's

Response: _____

cc: FAA Contracting Officer, FAA Project Engineer, A/E

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HOT WORK PERMIT
(for welding, cutting, or brazing activities)

THIS FORM MUST BE COMPLETED IN ITS ENTIRETY BY THE RESPONSIBLE PERSON PERFORMING
THE HOT WORK, OR THE RESIDENT ENGINEER OVERSEEING THE CONTRACTOR WHO IS
PERFORMING THE HOT WORK.

Facility ID and Type: _____ Date: _____
Responsible Person: _____ Start Time: _____
Finish Time: _____
Work to be performed: _____ Building: _____

_____ Room Number, Area or Equipment: _____

Is it possible to perform this work in a welding shop or other type of workshop? Yes No

Complete the checklist below and if any of the tasks have not been completed, please provide, in the comments section the reasons for not completing the tasks and the precautionary measures that will be implemented.

<u>Task</u>	<u>Yes</u>	<u>No</u>	<u>Comments and/or Corrective Measures</u>
Flame or spark-producing equipment to be used has been inspected and found in good repair.			
Fire Alarm systems are operational and will not be taken out of service while welding, cutting, or brazing activities are performed. If necessary, the automatic smoke detectors in the immediate vicinity of the hot work may be temporarily disabled via functions at the fire alarm control panel or otherwise covered, and returned to operational immediately following the smoke producing activities associated with the hot work.			
Sprinklers, where provided, are operational and will not be taken out of service while this work is being done.			
There are no combustible fibers, dusts, vapors, gases or liquids in the area.			
The work will only be performed in the area specified on this permit.			
Surrounding floors have been swept clean and, if combustible, wet down.			
All floor and wall openings within 35 feet of the operations have been tightly covered.			
All combustibles have been relocated at least 35 feet from the operation. If no, then are barriers or guards used to contain the heat, sparks and slag. Protection should include metal guards or flame- proofed curtains, blankets, or covers (not ordinary tarpaulins (tarps)).			

<u>Task</u>	<u>Yes</u>	<u>No</u>	<u>Comments and/or Corrective Measures</u>
A "Fire Watch" will be posted in area of activity, prior to starting welding, cutting, and brazing activity, and will patrol the area, including floors above and below, during any lunch or rest period and for at least one-half hour after the work has been completed to ensure the sparks and slag have not started fires.			
If bystanders and/or fire watch may be exposed to UV or burn hazards they will be appropriately protected with PPE.			
Fire extinguisher available for instant use within 20 ft.			
Cutter/welder is trained in safe operation of equipment and the safe use of the process.			
On-site contractors were advised about flammable material or hazardous conditions of which they may not be aware.			
Welding or cutting on material containers that contain or did contain flammables: Container thoroughly cleaned and ventilated; Any pipe lines or connections to containers disconnected or blanked; and Approved by ROSHM or EOSH Coordinator.			
Personal Protective Equipment (PPE) used: Eye protection Helmets Protective clothing Other (Specify)			
Warning sign posted to warn of hot metal.			
Appropriate ventilation provided.			
When working in confined spaces a permit has been issued as per 1910.146 and local Confined Space Program.			

For specific requirements refer to General Industry Standards 1910.146; 1910.252; .253; .254 and .272 and Construction Standards 1926.803; .350; .352 and .353.

I attest that the above precautions have been taken:

Printed Name of Person Responsible
for Performing Hot Work

Signature

Approval:

Facility Manager - Printed Name

Facility Manager - Signature

NOTE: THIS PERMIT EXPIRES 24 HOURS AFTER THE DESIGNATED "START TIME". IF WORK IS TO CONTINUE ANOTHER PERMIT MUST BE ISSUED.

MAINTAIN THE COMPLETED AND APPROVED PERMITS ON FILE FOR A MINIMUM OF ONE YEAR.

SECTION 01 10 15 - ACRONYMS AND DEFINITIONS

PART 1 - GENERAL

1.1 ACRONYMS AND DEFINITIONS

- A. When in the Special Provisions, this specification, drawings, specifications, or documents pertaining to this contract, the following terms are used; the intent and meaning shall be as specified herein.

1. AMS - Acquisition Management System
2. AMSL - Above Mean Sea Level
3. AOA - Air Operations Area
4. ARCHITECT - Architectural Engineering Firm of Record
5. ATCT - Airport Traffic Control Tower
6. CAI - Contractors Acceptance Inspection or Substantial Completion
7. CFM - Contractor-Furnished Material
8. CO - FAA Contracting Officer
9. Contr. - Contractor
10. COR - FAA Contracting Officer Representative (Fulltime Onsite Representative of the FAA and is also referred to as the COTR) Contracting Officer's Technical Representative
11. DESIGNER - Architectural Engineering Firm of Record
12. ENGINEER - Architectural Engineering Firm of Record
13. FAA - Federal Aviation Administration (Owner)
14. FAA Field Representative – COR
15. GFE - Government-Furnished Equipment
16. GFM - Government-Furnished Material
17. GOVERNMENT - FAA
18. IAW - In Accordance With
19. MSL - Mean Sea Level
20. NEC - National Electric Code
21. NTP - Notice to Proceed
22. OSHA - Occupational Safety and Health Administration
23. Owner - FAA
24. RE - FAA Contracting Officer Representative (Fulltime Onsite Representative of the FAA and is also referred to as the COR or Resident Engineer).
25. RWY - Runway
26. Sponsor - Airport Owner or Airport Authority
27. Substantial Completion - CAI
28. TWY - Taxiway
29. U/L or UL - Underwriters Laboratories
30. ILM - Airport

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 10 15

SECTION 01 25 00-SUBSTITUTION PROCEDURES

PART 1 – GENERAL

1.1 DEFINITIONS

A. Substitution: Any product or material that is submitted that is not the exact make and model number of the design basis shall be considered a substitution. This includes products that are from the same manufacturer but are different models. If the design basis is discontinued or obsolete, any product replacement is also considered a substitution. All substitutions shall follow the substitution procedures listed herein.

B. Known Acceptable Source: A manufacturer of a particular product or material that has been utilized successfully on past FAA projects. This is not an indication that a particular manufacturer will meet the requirements of each FAA project, only that they have been found to meet the requirements on past projects.

1.2 SUBSTITUTION PROCEDURE

- A. Submission of request for substitution shall constitute a representation by the Contractor that he:
1. Has investigated the proposed product and determined that it is equal to or better than the specified product. Absence of an explicit comparison of any characteristic of the proposed product to the specified product shall constitute a representation that the proposed product is equal to or better than the specified product with regard to that characteristic.
 2. Will provide the same warranty for the proposed product as for the specified product.
 3. Will coordinate the installation and make other changes which may be required for the work to be complete in all respects, including:
 - a. Redesign.
 - b. Additional components and capacity required by other work affected by the change.
 4. Waives all claims for additional costs and time extensions which subsequently may become apparent, and which are caused by the change.
 5. Will reimburse the Government for additional costs for evaluation of the substitution request, redesign if required, and reapproval by authorities having jurisdiction if required.
- B. Substitutions will not be considered when acceptance would require substantial revision of the contract documents.
- C. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request.
- D. Substitution requests will not be considered when submitted directly by subcontractor or supplier.

- E. Substitution Request Procedure: Submit written request with complete data substantiating compliance of the proposed product with the requirements of the contract documents.
1. Submit request to the Contracting Officer Representative.
 2. Submit 3 copies of each request and accompanying data.
 3. Submit all requests on a standard form provided.
 4. Only one request for substitution will be considered for each product.
- F. Data Required with Substitution Request: Provide at least the following data:
1. Identify product by specification section and paragraph number.
 2. Manufacturer's name and address, trade name and model number of product (if applicable), and name of fabricator or supplier (if applicable).
 3. Complete product data.
 4. A list of other projects on which the proposed product has been used, with project name, and the design professional's name.
 5. An itemized comparison of the proposed product to the specified product.
 6. Net amount of change to the contract sum.
 7. List of maintenance services and replacement materials available.
 8. Statement of the effect of the substitution on the construction schedule.
 9. Description of changes that will be required in other work or products if the substitute product is approved.
- G. The Contracting Officer Representative will determine acceptability of the proposed substitution.
- H. When the proposed substitution is not accepted, provide the product (or one of the products, as the case may be) specified.

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

NOT USED

END OF SECTION 01 25 00

PRODUCT SUBSTITUTION REQUEST FORM

Note: This form to be used by General Contractor only. Requests by others will be returned with no response.

Project:

Location: _____

Government: _____

Date: _____

We hereby submit for your consideration the following substitution instead of the item specified or shown on the Drawings:

Section Number:	Paragraph	Specified item

Proposed Substitution: _____

Attach complete product data, drawings and descriptions of products, with fabrication and installation details. Provide laboratory tests if applicable.

Provide sample, if applicable. Indicate if sample will be provided under separate cover.

Include complete information on changes to Drawings and/or Specifications that proposed substitution will require for its proper installation.

Fill in blanks below: *(Include attachments if space is insufficient. Failure to provide information will void submittal)*

A. Reason(s) for proposed substitution: *(check all that apply)*

- _____ 1. Request is equivalent to product/material/assembly specified. *(Note: Attach technical documentation)*
- _____ 2. Specified product or method cannot be provided within the Contract time. *(Note: This request will not be considered if the product or method cannot be provided as a result of the Contractor's failure to pursue the Work promptly, or to coordinate the various activities properly, or if the Contractor fails to place timely orders)*
- _____ 3. Specified product or method cannot receive necessary approval by authority having jurisdiction, and Contractor certifies that the requested substitution can be approved. *(Note: Attach approval documentation)*
- _____ 4. A substantial advantage is offered the Government, in terms of cost, time, energy conservation or other considerations of merit, after deducting redesign and evaluation costs of other work by the Government or separate contractors and similar considerations.

- _____ 5. Specified product or method cannot be provided in a manner which is compatible with other materials of the Work, and the Contractor certifies that the substitution will overcome the incompatibility.
- _____ 6. Specified product cannot be properly coordinated with other materials in the Work, and the Contractor certifies that the proposed substitution can be properly coordinated.
- _____ 7. Specified product or method cannot receive a warranty as required by Contract Documents, and Contractor certifies that the proposed substitution can receive required warranty.

B. B. Does the substitution affect dimensions or details shown on Drawings:

_____ No

_____ Yes (*Note: Attach marked up prints of drawings showing changes required*)

C. C. What effect does the substitution have on other trades?

D. D. Compare significant qualities of proposed substitution with those of work or product originally specified or shown on drawings. Include elements such as size, weight, durability, performance, visual effect, etc.

E. E. Coordinate information. Include all changes required in other elements of the work in order to accommodate the substitution, including work performed by Government or separate contractors.

F. F. State effect substitution will have on the work schedule in comparison to the schedule which would prevail without the proposed substitution. State the effect of the proposed substitution on Contract Time.

G. G. Provide complete cost information, including a proposal of any net change in the Contract Amount.

H. H. Manufacturer's warranties of the proposed substitution and specified items are:

_____ Same

_____ Different (*Note: Explain on attachment*)

The undersigned Contractor certifies its opinion that, after thorough evaluation, the proposed substitution will result in work that in every significant respect will be equivalent to or superior to the work required by the original Contract Documents and that it will perform adequately in the application indicated. Rights to additional payment or time because of failure of the substitution to perform adequately are hereby waived.

The undersigned hereby agrees to pay in full for any changes to design, including detailing and engineering costs caused by the requested substitution.

Submitted by: *(Note: Submittal void and will be discarded if unsigned or if signed by entity other than Contractor)*

Signature:

(Contractor's authorized representative)

(Title)

Firm Name:

Date:

For use by Contracting Officer Representative:

_____ **Accepted**

_____ **Accepted as Noted**

_____ **Not Accepted**

_____ **Received too late**

By: _____ Date: _____
(Contracting Officer Representative)

By: _____ Date: _____
(Contracting Officer Representative)

Remarks:

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Administrative and supervisory personnel.
 - 3. Coordination drawings.
 - 4. Requests for Information (RFIs).
 - 5. Project Web site.
 - 6. Project meetings.

1.2 DEFINITIONS

- A. RFI: Request from COR, Designer, or Contractor seeking information from each other during construction.

1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination Drawings, General: Government furnished BIM files (if any) shall be updated by the Contractor to include layout and facility data shown on Shop Drawings, product submittals and material submittals approved in accordance with Section 01 33 00.
- C. Project Coordination Schedule: The General Contractor will prepare and maintain a mutually agreed upon spatial coordination schedule with coordination drawing submittal milestones that meet the overall project construction schedule. Coordination drawing development, coordination submittal drawing submission and review by the COR, fabrication duration, and delivery lead times will be included to support the project construction schedule.

- D. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for COR and separate contractors if coordination of their Work is required.
- E. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Pre-installation conferences.
 - 7. Project closeout activities.
 - 8. Startup and adjustment of systems.
 - 9. Project closeout activities.
- F. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as FAA's property.

1.4 KEY PERSONNEL

- A. Key Personnel Names: Within 14 calendar days of Notice To Proceed, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
 - 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 CONTRACTOR PERSONNEL REQUIREMENTS

- A. Project Manager with a minimum of a Bachelor of Science (BS) degree in Civil, Mechanical, or Electrical Engineering from an accredited institution of higher learning, or a technical degree, and ten (10) years of experience with coordinating subcontractors on projects with complex mechanical, electrical, and control systems in the heavy construction industry.

- B. Project Superintendent with a minimum of ten (10) years of experience in coordinating mechanical, electrical, and control subcontractors in heavy construction industry.
- C. Project Scheduler with minimum of five (5) years of experience in coordinating large complex construction projects involving multiple construction disciplines with a typical project length of 18 or more months.

1.3 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified to the COR.
 - 1. COR will return RFIs submitted by other entities controlled by Contractor with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 - 1. Project name.
 - 3. Project number.
 - 4. Date.
 - 5. Name of Contractor.
 - 6. Name of COR.
 - 7. RFI number, numbered sequentially.
 - 8. RFI subject.
 - 9. Specification Section number and title and related paragraphs, as appropriate.
 - 10. Drawing number and detail references, as appropriate.
 - 11. Field dimensions and conditions, as appropriate.
 - 12. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 - 13. Contractor's signature.
 - 14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Refer Section 01 10 12 Construction Administration Forms.
- D. COR's Action: COR will review each RFI, determine action required, and respond. Allow fourteen (14) calendar days for COR's response for each RFI. RFIs received by COR after 1:00 P.M. local time will be considered as received the following working day.
 - 1. The following RFIs will be returned without action:

- a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of Designer's actions on submittals.
 - f. Incomplete RFIs or inaccurately prepared RFIs.
2. COR's action may include a request for additional information, in which case COR's time for response will date from time of receipt of additional information.
3. COR's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify COR in writing within four (4) calendar days of receipt of the RFI response.
- E. On receipt of COR's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify COR within seven (7) calendar days if Contractor disagrees with response.
- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use CSI Log Form 13.2B. Include the following:
 1. Project name.
 4. Name and address of Contractor.
 5. RFI number including RFIs that were dropped and not submitted.
 6. RFI description.
 7. Date the RFI was submitted.
 8. Date COR's response was received.
 9. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 10. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify COR of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Contractor shall record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including COR, within three days of the meeting.

- B. Preconstruction Conference: COR will schedule and conduct a preconstruction conference before starting construction, at a time convenient to COR, but no later than 15 days after execution of the Agreement.
1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of COR's; Contractor and its superintendent; ~~Contractor's Sustainable Design (LEED) Manager~~; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing/sequencing.
 - c. Permits
 - d. Critical work sequencing and long-lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Procedures for processing field decisions and Change Orders.
 - h. Procedures for RFIs.
 - i. Procedures for testing and inspecting.
 - j. Procedures for processing Applications for Payment.
 - k. Distribution of the Contract Documents.
 - l. Submittal procedures.
 - m. Sustainable design requirements.
 - n. Preparation of record documents.
 - o. Use of the premises.
 - p. Work restrictions.
 - q. Working hours.
 - r. FAA's occupancy requirements.
 - s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.
 - bb. Progress cleaning.
 - cc. Environmental requirements and procedures, including but not limited to:
 - 1) Erosion and Sediment control;
 - 2) Solid Waste Management Plan;
 - 3) IAQ Management Plan;
 - 4) Procedures for noise and acoustics management;
 - 5) Environmental Management Plan;
 - 6) Commissioning.
 4. Minutes: Contractor shall record and distribute meeting minutes.

- C. Pre-installation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise COR of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility problems.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written recommendations.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 3. Contractor shall record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a Project closeout conference, at a time convenient to the COR, but no later than 60 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.

2. Attendees: Authorized representatives of COR; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing sustainable design documentation.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for demonstration and training.
 - g. Preparation of Contractor's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures.
 - j. Coordination of separate contracts.
 - k. FAA's partial occupancy requirements.
 - l. Installation of FAA's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 4. Minutes: Contractor shall record and distribute meeting minutes.
- E. Progress Meetings: Construction manager shall conduct progress meetings at weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of the COR, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.

- 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
 - 19) Status of environmental plans.
 - 20) Commissioning efforts.
4. Minutes: Contractor shall record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to COR, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:

- 1) Revise list below to suit Project.
 - 2) Interface requirements.
 - 3) Sequence of operations.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Change Orders.
3. Reporting: Contractor shall record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

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SECTION 01 32 00 - CONTRACTOR-PREPARED NETWORK ANALYSIS SYSTEM

PART 1 - GENERAL

1.1 CONTRACTOR-PREPARED NETWORK ANALYSIS SYSTEM

- A. General: The progress chart to be prepared by the Contractor pursuant to the clause entitled "Schedules for Construction Contracts" shall consist of a network analysis system (NAS) as described below. In preparing this system the scheduling of construction is the responsibility of the Contractor. The requirement for the system is included to assure adequate planning and execution of the work and to assist the Contracting Officer in appraising the reasonableness of the proposed schedule and evaluating progress of work.
1. NAS Reference Guide: The United States Army Corps of Engineers' pamphlet EP 415-1-4 (31AUG86), "Network Analysis Systems Guide," is a primer on the subject and provides a basic introduction to network scheduling. Single copies of the guide are available to bona fide bidders on request. The system proposed for use will be accepted subject to the approval of the Contracting Officer.
 2. NAS Content: The system shall consist of diagrams and accompanying mathematical analyses. The diagrams shall show elements of the project in detail and the entire project in summary.
 - a. Diagrams: Diagrams shall show the order and the interdependence of activities and the sequence in which the work is to be accomplished as planned by the Contractor. The basic concept of a network analysis diagram will be followed to show how the start of a given activity is dependent on the completion of preceding activities and its completion restricts the start of following activities.
 - b. NAS Items: Network activities shown on a detailed or subnetwork diagram shall include, in addition to construction activities, etc., submittal, review and approval of samples of materials and shop drawings, the procurement of critical materials and equipment, fabrication of special material and equipment and their installation and testing. Contract-required dates for completion of all or parts of the work will be shown. All activities of the Government and others that affect progress, including, but not limited to, the requirements in TECHNICAL SPECIFICATIONS, Paragraph GOVERNMENT-FURNISHED MATERIAL (GFM), shall be shown. The detail of information shall be such that duration times of activities will range from three (3) to thirty (30) days with not over two percent (2%) of the activities exceeding these limits. Activities involving the procurement, delivery and installation of major items of equipment shall be separated into a procurement and delivery activity and into an installation activity. The activities related to separate buildings and features shall be separately identifiable by coding or use of subnetworks or both. For new ATCT facilities, include not less than 2500 activities.
- 1) NAS Approval: The selection of activities shall be subject to the Contracting Officer's approval. Detailed networks, when summary

networks are also furnished, need not be time scaled but shall be drafted to show a continuous flow from left to right with no arrows from right to left; the critical path shall be clearly designated. The following information shall be shown on the diagrams for each activity: preceding and following event numbers, description of the activity, cost and activity duration in calendar days. In calculating activity durations, Saturdays, Sundays, holidays, and normal inclement weather shall be considered.

- c. Summary Network: If the project is of such size that the entire network cannot be readily shown on a single sheet, a summary network diagram shall be provided. The summary network diagram shall consist of a minimum of 50 activities and a maximum of 150 activities and shall be based on and supported by detailed diagrams. Related activities shall be grouped on the network. The critical path shall be plotted generally along the center of the sheet with increasing float placed towards the top or bottom. The summary network shall be time scaled using units of approximately one-half-inch equals one week or other suitable scale approved by the Contracting Officer. Weekends and holidays shall be shown. Where slack exists, the activities shall be shown at the time when they are scheduled to be accomplished.
- d. NAS Calculation: The mathematical analysis of the network diagram shall include a tabulation of each activity shown on the detailed network diagrams. The following information will be furnished as a minimum for each activity:
 - 1) Preceding and following event numbers (numbers shall be selected and assigned so as to permit identification of the activities with bid items)
 - 2) Activity description (identify the work to be performed)
 - 3) Estimated duration of activities (the best estimate available at time of computation in calendar days);
 - 4) Earliest start date (by calendar date)
 - 5) Earliest finish date (by calendar date)
 - 6) Actual start date (by calendar date)
 - 7) Actual finish date (by calendar date)
 - 8) Latest start date (by calendar date)
 - 9) Latest finish date (by calendar date)
 - 10) Slack or float (in calendar days)
 - 11) Monetary value of activity
 - 12) Responsibility for activity (Contractor, subcontractors, suppliers, Government, etc.)
 - 13) Percentage of activity completed
 - 14) Contractor's earnings based on portion of activity completed
 - 15) Bid item of which activity is a part
- e. NAS Capability: The program or means used in making the mathematical computation shall be capable of compiling the total value of completed and partially completed activities and subtotals from separate buildings or features listed in paragraph A.2.b. The program shall be capable of accepting revised completion dates as modified by approved time adjustments and recomputing all tabulation dates and float accordingly.

- f. Additional NAS Features: In addition to the tabulation of activities, the computation shall include the following data:
- 1) Identification of activities which are planned to be performed by use of overtime or multi-shifts to be worked including Saturdays, Sundays, and holidays.
 - 2) A description of the major items of construction equipment planned for operations of the project. The description shall include the type, number of units and unit capacities. A schedule showing proposed time equipment will be on the job keyed to activities on which equipment will be used shall be provided.
 - 3) The analysis shall list the activities in sorts or groups as follows:
 - a) By the preceding event number from lowest to highest and then in the order of the following event number.
 - b) By the amount of slack, then in order of preceding event number.
 - c) By responsibility in order of earliest allowable start dates.
 - d) In order of latest allowable start dates, then in order of preceding event numbers, and then in order of succeeding event numbers.
3. Submission and Approval: Submission and approval of the system shall be as follows:
- a. A preliminary network defining the Contractor's planned operations during the first seventy-five (75) calendar days after notice to proceed shall be submitted within ten (10) days after notice to proceed. The Contractor's general approach for the balance of the project shall be indicated. Cost of activities expected to be completed or partially completed before submission and approval of the whole schedule shall be included.
 - b. The complete network analysis consisting of the detailed network mathematical analysis and network diagrams shall be submitted within forty (40) calendar days after receipt of notice to proceed. A graph shall be included showing cumulative placement in dollar value over the life of the project. The vertical scale will show scheduled percent completion based on dollar value, from 0% to 100%. Show dollar amounts associated with various percentages, including 100%. The horizontal scale will be at a time scale showing the calendar months of the project. Three curves will be plotted on the same graph; the first will be percent completion based on early finish dates; the second will be percent completion based on late finish dates; the third will be a curve showing the average between percentages of early finish and late finish values.
 - c. All project schedule submittals must be submitted on a 700+MB compact disk or other approved portable electronic media and also uploaded to the FAA's KSN website. Media must be compatible with the system previously approved and installed on the COR's desktop computer (i.e., Primavera, or other approved scheduling software).
4. NAS Review and Evaluation. - The Contractor shall participate in a review and evaluation of the proposed network diagrams and analysis by the Contracting Officer. Any revisions necessary as a result of this review shall be resubmitted for approval of the Contracting Officer within ten (10) calendar days after the conference. The approved schedule shall then be the schedule to be used by the Contractor for planning,

organizing and directing the work and for reporting progress. If the Contractor thereafter desires to make changes in his method of operating and scheduling, he shall notify the Contracting Officer in writing stating the reasons for the change. If the Contracting Officer considers these changes to be of a major nature, he may require the Contractor to revise and submit for approval, without additional cost to the Government, all or the affected portion of the detailed diagrams and mathematical analysis and the summary diagram to show the effect on the entire project. A change will be considered to be of a major nature if the time estimated to be required or actually used for an activity or the logic of sequence of activities is varied from the original plan to a degree that there is a reasonable doubt as to the effect on the Contract completion date or dates. Changes which affect activities with adequate slack time shall be considered as minor changes, except that an accumulation of minor changes may be considered a major change when their cumulative effect might affect the Contract completion date.

5. Contractor Monthly Report: The Contractor shall submit at monthly intervals a report of the actual construction progress by updating the mathematical analyses. A copy of the entire updated schedule shall also be submitted monthly on a 700+ MB compact disk or other approved portable electronic media and uploaded to FAA's KSN website. Media shall be compatible with the system previously approved. Entering or updating information into the mathematical analysis will be subject to the approval of the Contracting Officer. Revisions causing changes in the detailed network shall be noted on the summary network, or a revised issue of affected portions of the detailed network furnished. The summary network shall be revised as necessary for the sake of clarity.
 - a. Report Content: The report shall show the activities or portions of activities completed during the reporting period and their total value as basis for the Contractor's periodic request for payment. Payment made pursuant to the Contract Clause entitled "Payments Under Fixed-Price Construction Contracts" will be based on the total value of such activities completed or partially completed after verification by the Contracting Officer. The report shall state the percentage of the work actually completed and scheduled as of the report date and the progress along the critical path in terms of days ahead or behind the allowable dates. If the project is behind schedule, progress along other paths with negative slack shall also be reported.
 - b. Narrative Report: The Contractor shall also submit a narrative report with the updated analysis which shall include but not be limited to a description of the problem areas, current and anticipated, delaying factors and their impact, and an explanation of corrective actions taken or proposed. Identification of problem areas within this report will not be acknowledged to constitute proper notification of any intended or potential claim. Any request for additional reimbursement must be made the subject of separate correspondence. The report shall include an updated version of the graph specified; actual completion percentages shall be shown, together with revisions to the scheduled completion dates.
 - c. Cumulative Asset Cost Report: This report shall be prepared by the Contractor and shall provide an accounting of the cumulative costs for month for the assets defined in paragraph 1.2 of this specification section. This information is necessary for the FAA to know the exact cost of the above referenced assets in order to capitalize the assets at the end of the project. The reports shall show the activities or portions of activities completed during the reporting period and their total value

as basis for the Contractor's periodic request for payment. Payment made will be based on the total value of such activities completed or partially completed after verification by the Contracting Officer. The report will state the percentage of the work completed and scheduled as of the report date and the progress along the critical path in terms of days ahead or behind the allowable dates. If the project is behind schedule, progress along other paths with negative slack shall also be reported. The Contractor shall include but not be limited to a description of the problem areas, current and anticipated, delaying factors and their impact, and an explanation of corrective actions taken or proposed.

6. Sheet size of diagrams shall be 30 by 42 inches. Each updated copy shall show a date of the latest revision.
7. Initial submittal and complete revisions shall be submitted in four (4) copies (including one reproducible).
8. Monthly reports and schedule analysis (printout) shall be submitted in three (3) copies
9. Changes affecting the project schedule: When changes affecting the network or work schedule are necessary, the Contractor will submit revisions to the network for all activities affected in response to the request for proposal. All changes shall be shown as separate activities on the network. The Contractor will prepare a Time Impact Analysis, which will be based on the current schedule data, job conditions, and progress achieved at the time the change is issued or the delay occurs. The Contractor will submit a separate Time Impact Analysis sheet, which will include proper identification, references, adequate description, details of evaluation including network calculation, and conclusion that establish the Contractor's position on the effect of the change. If settlement has not been reached on the price and/or time of the proposed change order prior to Notice to Proceed, or the Contractor has failed to submit revisions to the network logic, the Contracting Officer may furnish to the Contractor the suggested logic and/or duration time changes to be entered into the network and used in all subsequent updating reports until such time that the proposed change order has been settled or until the logic and duration are superseded. Inclusions in the network and use of revised logic and/or duration time estimates for updating, whether furnished by the Contractor or by the Contracting Officer, shall not be construed as extensions of time to the dates required in the Contract. These changes are for the purpose of keeping the schedule up to date to reflect the work to be accomplished and to include the best time estimates for work yet to be done. If it becomes necessary for the Contracting Officer to furnish the suggested logic and/or duration time revisions because of the Contractor's failure to furnish acceptable data on time, and if the Contractor has any objections to the data furnished by the Contracting Officer, he shall advise the Contracting Officer promptly, in writing, of such objections fully supported by his own counterplan; however, he will continue to use the revisions suggested by the Contracting Officer for all updating until such time as the Contracting Officer may approve alternate data. If the Contractor fails to submit, in writing, his objections to the revisions along with supporting data and counterplan within twenty (20) days after the date such suggested revisions were furnished by the Contracting Officer, the Contractor will be deemed to have concurred in the Contracting Officer's suggested logic/duration time changes, which changes then will be the basis for equitable adjustment of the time for performance of the work

10. Float or Slack Time: Float or slack is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, of any of the activities in the NAS schedule. Float or slack is not time for the exclusive use of or benefit of either the Government or the Contractor. Extensions of time for performance required under the Contract Clauses entitled "CHANGES," "DIFFERING SITE CONDITIONS," "DEFAULT," or "SUSPENSION OF WORK" will be granted only to the extent that the equitable time adjustments for the activity or activities affected exceed the total float or slack along the channels involved at the time Notice to Proceed was issued for the change.
11. Contract Progress Monitoring: The Contractor shall provide the Government with the means to independently obtain and process information from the network analysis data. This capability shall be accomplished as follows:
 - a. Contractor Furnished Computer Hardware and Software: Contractor shall acquire commercially available NAS software and install an original version of the software on the Contracting Officer Representative's computer. The NAS software installed on the Contracting Officer Representative's computer shall match the software that will be used by the Contractor and shall be fully compatible with the Resident Office's computer hardware and that will process the network data provided by the Contractor with no further computer translation. The Contractor shall initially install the program on all contractor furnished personal computers for government use and shall maintain the software throughout the contract period. The Contractor shall provide all of the software updates that are incorporated into the Contractor's program. The Contractor shall also provide 5 working days of training to the COR on the use of the furnished software. The software shall remain the property of the Contractor but shall be in the possession of and for the exclusive use by the Government during the contract period. The Contractor may repossess the software after final payment is made on the contract.
12. Additional Reporting: The Contractor shall additionally provide monthly progress information including revised logic, actual activity start dates, actual activity finish dates, and revised activity durations on 700+ MB compact disks, or other approved electronic media. This information, either without further computer translation or with Contractor-provided computer translation, shall be capable of being processed with the hardware and software being used in the Contracting Officer Representative Office for network analysis system processing.
13. Submission of Contractor Monthly Report shall be required for periodic progress payment.

1.2 GOVERNMENT ASSET CODING

- A. Progress payments shall be coded as per the following typical Government assets:
 1. Air Traffic Control Tower
 2. TRACON Base Building

1.3 REQUIRED MILESTONES

- A. Include, as a minimum the following milestones in the schedule.
1. HVAC System Started Up
 2. Above Ceiling Inspections Complete
 3. HVAC System Commissioned
 4. CAI Complete
 5. CAI Punchlist Complete

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 32 00

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SECTION 01 32 00.20 - CONTRACTOR-PREPARED CONSTRUCTION SCHEDULE

PART 1 - GENERAL

1.1 CONTRACTOR-PREPARED CONSTRUCTION SCHEDULE

- A. Progress Chart - The Contractor shall prepare a detailed construction schedule for the project. The schedule shall be coordinated with the COR and include all milestone activities. The scheduling of construction is the responsibility of the Contractor and Contractor management personnel shall actively participate in its development. The requirement for the schedule is included to assure adequate planning and execution of the work and to assist the Contracting Officer (CO) in evaluating progress of work. Submit the Construction Schedule to the CO within ten (10) calendar days after contract award.

Format - The construction schedule shall consist of a diagram or a bar chart showing the start and end dates of construction as well as the major items to be constructed, what work is occurring, length of time anticipated for the activity and the flow of construction.

Diagram(s) shall show the order and interdependence of activities and the sequence in which the diagram will be followed to show how the start of a given activity is dependent on the completion of preceding activities and its completion restricts the start of following activities.

Diagram activities shall include, in addition to construction activities, the submittal, review and approval of samples of materials and shop drawings, the procurement of critical materials and equipment, fabrication of special materials and equipment and their installation and testing. All activities of the Government and others that affect progress, and contract required dates for completion of all parts of the work shall also be shown.

The construction schedule consists of a minimum of 20 activities. The selection of activities shall be subject to the Contracting officer's approval.

- B. Monthly reports. - The Contractor shall submit, as part of the monthly request for payment, three (3) hard copies of the following items
- a. An updated construction schedule showing the actual construction progress and its current status.
 - b. Cumulative Asset Cost Report

Cumulative Asset Cost Report: This report shall be prepared by the Contractor and shall provide an accounting of the cumulative costs for month for the following assets:

- a. Air Traffic Control Tower – Asset 2010A
- b. Base Building – Asset 2011A

This information is necessary for the FAA to know the exact cost of the above referenced assets in order to capitalize the assets at the end of the project.

The reports shall show the activities or portions of activities completed during the reporting period and their total value as basis for the Contractor's periodic request for payment. Payment made will be based on the total value of such activities completed or partially completed after verification by the Contracting Officer. The report will state the percentage of the work completed and scheduled as of the report date and the progress along the critical path in terms of days ahead or behind the allowable dates. If the project is behind schedule, progress along other paths with negative slack shall also be reported. The Contractor shall include but not be limited to a description of the problem areas, current and anticipated, delaying factors and their impact, and an explanation of corrective actions taken or proposed.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 32 00.20

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires COR's responsive action.
- B. Informational Submittals: Written information that does not require COR's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

- A. General: Electronic copies of the CAD files of the Contract Drawings will be provided by COR for Contractor's use.
- 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. COR reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Submittals Schedule: Not applicable.
- D. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on COR'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 30 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. COR 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 14 days for review of each resubmittal.

4. Sequential Review: If sequential review of submittals by COR's consultants, FAA, or other parties is required, allow 30 workdays for initial review of each submittal.
- E. 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 3 by 4 inches on label or beside title block to record Contractor's review and approval markings and action taken by COR.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Contractor.
 - d. Name and address of subcontractor.
 - e. Name and address of supplier.
 - f. Name of manufacturer.
 - g. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
 - j. Location(s) where product is to be installed, as appropriate.
 - k. Other necessary identification.
- F. Deviations: Encircle or otherwise specifically identify deviations from the Contract Documents on submittals. Indication must be reproducible when copied on black and white copier.
- G. Additional Copies: Unless additional copies are required for final submittal, and unless COR observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
 1. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.
- H. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Transmittal form associated with submittals received from sources other than Contractor will be returned without review. Submittal itself may be returned at the COR discretion.
 1. Transmittal Form: 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, as appropriate.
 - 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 COR on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same label information as related submittal.
- I. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked as being accepted.
 4. Resubmittals previous marked "no exception taken" or resubmittals not specifically marked "revise and resubmit" will not be reviewed.
- J. Request For Variations: Variations from contract requirements require Government approval pursuant to contract clause entitled "Specifications and Drawings for Construction" and will be considered where advantageous to the Government. Where variations are proposed for consideration, submit a written request, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to the Government and must include cost savings to the Government. The proposed variation shall be identified separately and included along with the required submittal for the item. When a variation is submitted for approval, the Contractor warrants the following.
 1. The Contract has been reviewed to establish that the variation, when incorporated, will be compatible with other elements of the work.
 2. The Contractor shall take action and bear the additional cost, including review costs by the Government, necessary because of the proposed variation.
 3. The Contractor shall bear the cost of employing a registered professional engineer to provide stamped calculations certifying that the variation meets the project criteria.
- K. 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.
- L. Use for Construction: Use only final submittals with mark indicating that no exceptions are taken by COR.

1.4 CONTRACTOR'S USE OF CAD FILES

- A. General: Contract document CAD files will be provided to Contractor for Contractor's use in connection with Project, subject to the following conditions:
 1. While every effort has been made to ensure the accuracy of the information contained in the CAD drawing files, the FAA shall not be responsible for any mistake or inaccuracy

that may be contained herein and all such liability and responsibility are expressly disclaimed by the FAA.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
 - 1. Submit electronic (pdf) format submittals directly to the Knowledge Services Network (KSN) specifically established for Project. If files are too large for KSN, submittal of paper copies and CDs will be required.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operation and maintenance manuals.
 - k. Compliance with specified referenced standards.
 - l. Testing by recognized testing agency.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.
 - 4. Submit Product Data before or concurrent with Samples.
 - 5. Format: Submit Product Data in electronic (pdf) format directly to the KSN, unless otherwise indicated. COR will return marked up electronic copy and retain one copy as a Project Record Document.
- 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 in (pdf) format on sheets at least 8-1/2 by 11 inches. The resolution for full size electronic (pdf) files shall be fully legible for on screen viewing which is equivalent to a full size 22 x 34 plot.
 - 3. Format: Submit Shop drawings in electronic (pdf) format directly to the KSN, unless otherwise indicated. COR will return marked up electronic copy and retain one copy as a Project Record Document.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
- 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of appropriate Specification Section.
 - 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as FAA's property, are the property of Contractor.
 - 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

- a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. COR will return submittal with options selected.
- E. Product Schedule or List: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Type of product. Include unique identifier for each product.
 - 2. Number and name of room or space.
 - 3. Location within room or space.
 - 4. Number of Copies: Submit two paper copies and two electronic of product schedule or list, unless otherwise indicated. COR will return one copy.
- F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation".
- G. Application for Payment: Comply with requirements.
- H. Schedule of Values: Comply with requirements.
- I. Submittals required prior to Notice-to-Proceed: Not Applicable.
- J. Subcontract List: 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. Use Standard Form (SF) 1413. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
 - 4. Number of Copies: Submit two copies of subcontractor list, unless otherwise indicated. COR will return one copy.
 - a. Mark up and retain one returned copy as a Project Record Document.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 - 1. Number of Copies: Submit two paper copies and one electronic copy of each submittal, unless otherwise indicated. COR will not return copies.
 - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - 3. Test and Inspection Reports: Comply with requirements.

- B. Coordination Drawings: Comply with requirements specified in Section 01 31 00, "PROJECT MANAGEMENT AND COORDINATION."
- C. Contractor's Construction Schedule: Not Used.
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- J. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- M. Schedule of Tests and Inspections: Comply with requirements.

- N. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- O. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- P. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- Q. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."
- R. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- S. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
 - 1. Preparation of substrates.
 - 2. Required substrate tolerances.
 - 3. Sequence of installation or erection.
 - 4. Required installation tolerances.
 - 5. Required adjustments.
 - 6. Recommendations for cleaning and protection.
- T. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
 - 1. Name, address, and telephone number of factory-authorized service representative making report.
 - 2. Statement on condition of substrates and their acceptability for installation of product.
 - 3. Statement that products at Project site comply with requirements.
 - 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 6. Statement whether conditions, products, and installation will affect warranty.
 - 7. Other required items indicated in individual Specification Sections.

- U. Material Safety Data Sheets (MSDSs): All product submittals must be accompanied with Material Safety Data Sheets (MSDS) from the manufacturer.

2.3 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to COR.

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 COR.
- 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.
- C. Ensure no work is begun until the submittals for that work have been returned with a review comment other than "Revise and Resubmit" or "Rejected".

3.2 COR'S / ACTION

- A. General: COR will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: COR will review each submittal, make marks to indicate corrections or modifications required, and return it. COR will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 - 1. No Exceptions Noted (Do not Re-Submit)
 - 2. Exceptions Noted
 - 3. Revise and Re-Submit
 - 4. Rejected
 - 5. Not Required

The FAA may retain a construction support contractor for submittal review and other engineering support functions. The construction contractor acknowledges that no submittal, RFI, or any other information will be received directly from the construction support contractor. All infor-

mation received from the construction support contractor must be validated by the FAA COR before it is considered an official response to the submittal RFI, or information inquiry.

- C. Informational Submittals: COR will review each submittal and will not return it, or will return it if it does not comply with requirements. COR will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 01 33 00

SECTION 01 35 33 - INFECTION CONTROL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

This supplemental document provides requirements Contractor must take to reduce the spread and/or exposure of COVID –19 on FAA contracts at Federal Aviation Administration (FAA) facilities.

The term “Contractor” in this document will include the Contractor employees, sub-Contractor employees, delivery personnel, and visitors.

1.2 COVID-19 SAFETY PLAN

The COVID-19 Safety Plan (CVSP) must include, but is not limited to, the following:

- A. COVID-19 Wellness Self-Check (See Appendix A), this is a sample Wellness Self-Check questionnaire. Contractor should refer to CDC and local guidance for latest symptoms self- check list.
 - 1. Contractor must conduct and complete the Wellness Self-Check form prior to reporting to the FAA facility and/or work site. The Contractor Superintendent/COVID-19 Safety Officer must review each form.
 - 2. The person responsible for administering the Wellness Self-Check must have authority to deny anyone entering the FAA work site who displays any symptoms prior to entering, as well as authority to remove persons develop symptoms after beginning work at the FAA facility.
 - 3. Wellness Self-Check must be completed immediately prior to accessing the FAA work site. Contractor must note in their CVSP the physical location of where Wellness Self- check will be completed. Testing site must be outside the FAA property.
 - 4. Contractor must take same precautions for deliveries entering FAA property regardless of driver exiting truck.
 - 5. CVSP must include how Contractor plans to manage the delivery of product samples, batch tickets, and large project/shop drawings to the FAA.
- B. COVID-19 Exposure Reduction Plan:
 - 1. Face Covering: Contractor must wear a face covering while on the FAA work site when social distancing is not practicable and/or in common areas within a FAA facility. All face coverings, at a minimum, must adhere to the following:
 - a. Cover the nose and mouth.

- b. Fit snugly, but comfortably, against the side of the face,
 - c. Be secured with ties or ear loops,
 - d. Allow breathing without restrictions; and
 - e. Include multiple layers of fabric.
- 2. Physical Separation (6 foot spacing between workers)/Social Distancing Controls will be required at all times.
- 3. Contractor must identify in their CVSP, when use of physical separation and/or face covering is not practicable due to thermal stress, and/or confined space requirements, or other reasons; and how the Contractor plans to mitigate those circumstances.
- 4. Personal Hygiene: Contractor must employ good hygiene practices while within the FAA facilities. These practices must include, but not limited to:
 - a. The use of hand washing and hand sanitizing stations. Hand sanitizer must be FDA approved.
 - b. Disinfection of frequently used items and surfaces as much as possible. Use EPA N List approved wipes and/or disinfectant supplies.
- C. Job exposures as defined by OSHA work type.
- D. List of COVID-19 Safety Personnel
- E. COVID-19 Informational posters/displays (Appendix B)
- F. Contractor Communication Plan (if someone tests positive or becomes ill at the work site)
- G. Proper disposal of COVID-19 PPE
- H. Include state, county, and local guidelines specific to job location
- I. Engineering controls
- J. Use of shared tools

1.3 ADDITIONAL COVID-19 REQUIREMENTS

- A. Prior to departing the FAA work site, the Contractor must wipe and disinfect all high touch point areas with approved wipes and/or disinfectant. High touch point areas include, but not limited to:
 - a. Doors and door hardware
 - b. Handrails
 - c. Thermostats
 - d. Gates
 - e. Light controls
 - f. Desks
 - g. Telephones
 - h. Chairs
- B. Contractor must provide separate temporary sanitary facilities dedicated to FAA and separate from Contractor use. Contractor is not permitted to use FAA restrooms within a facility. High touch points on/within the temporary sanitary facilities (door handles, toilet seat, etc.) must be wiped and disinfected after each use by the individual using the facility. Contractor must supply the required wipe and/or

disinfecting supplies.

1.4 SITE ACCESS/EGRESS

- A. The Contractor must meet with the FAA's Contracting Officer Representative (COR) and local FAA management prior to the start of the project to establish the Contractors' access, badging, and security requirements.
- B. If a Contractor is not feeling well for any reason and COVID-19 symptoms exist, the individual will be denied access to the FAA facility. If a Contractor develops COVID-19 symptoms while at the FAA facility, the Contractor is required to immediately remove the symptomatic individual from the FAA facility, notify the FAA Contracting Officer (CO) and/or COR and immediately inform the FAA of any concerns regarding the work that was expected to be performed by that Contractor. The Contractor must also provide details on all locations where the symptomatic individual visited within the FAA facility.

1.5 FAA NOTIFICATIONS

- A. Contractor is required to notify the FAA immediately when a suspected or confirmed case of COVID-19 has visited the FAA facility and/or work site within past 14 days; been in contact with someone that may have visited a FAA facility; and/or had contact with a FAA employee and/or another agency Contractor. Reporting must include the information outlined below to allow the FAA to make a timely and appropriate response. Report any suspect or confirmed cases to 9-AFN-ACQ-EM@faa.gov, with a courtesy copy to the CO and COR. The report must include, for each affected individual:
 - a. Date of self-quarantine
 - b. Whether the case is suspected or confirmed.
 - c. Where the individual visited (building address) or with whom they met and the date of latest contact.
 - d. To ensure privacy information is protected, do not include specific information about the individual via e-mail.
 - e. Once information is received, a FAA official will contact the Contractor directly to obtain additional information regarding the case(s) to coordinate a proper response.
- B. Provide medical documentation by an authorized medical professional stating the individual no longer poses a transmission risk and is safe to re-enter the FAA work site. Return to work documentation must be provided to the CO and COR.

1.6 SUBMITTALS

- A. The Contractor must provide the following:
 - a. COVID-19 Safety Plan
 - b. Washing/Sanitizing Station(s)

- c. Temporary/Portable Sanitary Facility
- d. Cleaning/Disinfection supply Safety Data Sheets (SDSs)
- e. Hand Sanitizer SDSs
- f. SDSs for all chemicals brought into the FAA facility

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

- A. Shared use of trailer between FAA and Contractor personnel is not permitted.
- B. All meetings must take place virtually where practicable.
- C. In an occupied facility, Contractor must make use of floor plans or other methods to track all the personnel on job site including documenting time entered and exited.
- D. Use of trailer restrooms are highly encouraged. Trailer restroom must have a hand washing station and must be equipped with an exhaust fan.
- E. FAA is using data from Harvard Dashboard <https://globalepidemics.org/key-metrics-for-covid-suppression/> to stay current with the local COVID-19 situation. If the number of COVID-19 cases increases in the area of work being performed, the CO may issue a *Stop Work Notice*. FAA highly encourages Contractor to monitor the local COVID-19 statistics via either Harvard dashboard or other official data that is available.
- F. Identify all the personnel coming from outside of the State/local commuting area at least one week prior to coming onto the FAA facility.

NOTE: Any breach to CVSP or other requirement listed in this document will result in removal of the Contractor and/or issuing *Stop Work Notice* by the CO.

CDC link - What Construction Workers Need to Know about COVID-19

<https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/construction-workers.html>

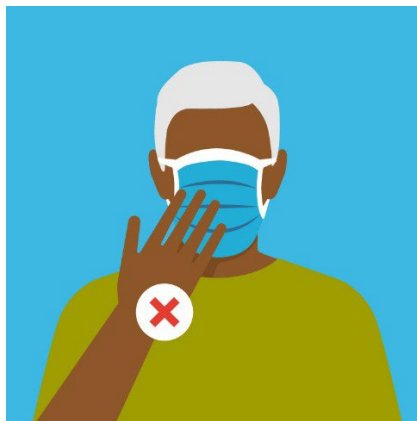
This supplement for the COVID-19 pandemic does not supersede or contradict any memo or directive that the Contracting Officer has already provided your company. While the overall responses can vary by location and may change as more information about the virus becomes available, the intent of this supplement is not to be contradictory. If your company feels that you have already received or receive future directions that contradicts this supplement or other memos sent by the Contracting Officer, please immediately seek clarification. As a reminder, only the Contracting Officer is authorized to implement changes to the contract and/or approve anything that would result in a schedule or cost change.

END OF SECTION

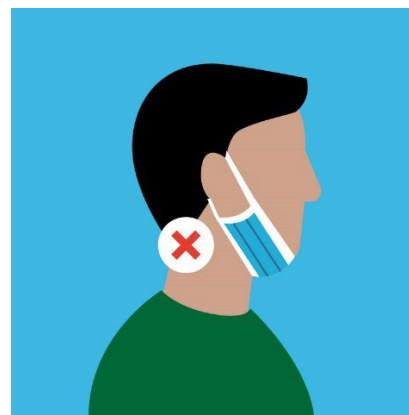
Appendix –A: Sample of Daily Questionnaire

Symptoms	Yes	No
Fever (above 100.4 °F (38°C) or higher)		
Shortness of Breath		
Difficulty in Breathing		
Chest Pain		
Chills		
Body aches or muscle aches		
Sore Throat		
Cough		
Headache		
Diarrhea		
Nausea/Vomiting		
Runny Nose		
New or worsening Loss of Taste/Smell		

Appendix B – Example of COVID-19 Safety Posters



Don't touch your mask while it is being worn



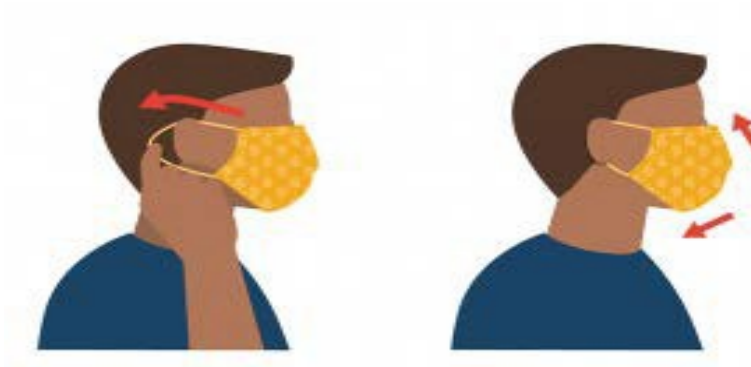
Don't wear the mask under your chin with your nose and mouth exposed



Don't leave your nose or mouth uncovered



Don't share your mask with family members or friends



Wear your Mask Correctly

SECTION 01 40 00 - CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.2 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A. ASTM D 3740 Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- B. ASTM E 329 Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.3 SUBMITTALS

- A. Contractor Quality Control Plan
- B. Contractor Quality Control Personnel
- C. Daily Logs

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- 3.2 The Contractor is responsible for quality control and must establish and maintain an effective quality control system. The quality control system must consist of plans, procedures, and organization necessary to produce an end product that complies with the contract requirements. The system must cover all construction operations, both onsite and offsite, and must be keyed to the proposed construction sequence. The site project superintendent will be held responsible for the quality of work on the job and is subject to removal by the COR for non-compliance with the quality requirements specified in the contract. The site project superintendent in this context must

be the highest-level manager responsible for the overall construction activities at the site, including quality and production. The site project superintendent must maintain a physical presence at the site at all times, except as otherwise acceptable to the COR, and must be responsible for all construction and construction related activities at the site. Similar requirements apply to the quality control manager. CONTRACTOR QUALITY CONTROL (CQC) PLAN

A. Content of the CQC Plan

1. The CQC Plan must include, as a minimum, the following to cover all construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:
2. A description of the quality control organization, including a chart showing lines of authority.
3. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.
4. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager must issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters must also be furnished to the Government.
5. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures must be in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES".
6. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities must be approved by the COR.)
7. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.
8. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures must establish verification that identified deficiencies have been corrected.
9. Reporting procedures, including proposed reporting formats.
10. A list of the definable features of work. A definable feature of work is a task that is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there is frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.

B. Acceptance of Plan: Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

C. Notification of Changes: After acceptance of the CQC Plan, the Contractor must notify the COR in writing of any proposed change. Proposed changes are subject to acceptance by the COR.

3.3 COORDINATION MEETING

- A. After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the CQC Plan, the Contractor must meet with the COR and discuss the Contractor's quality control system. The CQC Plan must be submitted for review a minimum of 7 calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details must be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the FAA's Quality Assurance. Minutes of the meeting will be prepared by the Contractor and signed by both the Contractor and the COR. The minutes must become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by the Contractor.

3.4 INDEPENDENT QUALITY CONTROL ORGANIZATION (CQC)

- A. Personnel Requirements: The requirements for the Independent CQC organization are a CQC System Manager and sufficient number of additional qualified personnel to ensure safety and contract compliance. QCQ Manager is required to complete the 16 hour "Construction Quality Management (CQM) for Contractors" course as offered by the Corps of Engineers. Personnel identified in Part D Experience Matrix requiring specialized skills to assure the required work is being performed properly will also be included as part of the CQC organization. The Contractor's CQC staff must maintain a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure contract compliance. The CQC staff must be subject to acceptance by the COR. The Contractor must provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Complete records of all letters, material submittals, shop drawing submittals, schedules and all other project documentation must be promptly furnished to the CQC organization by the Contractor. The CQC organization must be responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to the COR.
- B. CQC System Manager: The Contractor must identify as CQC System Manager an individual within the onsite work organization who must be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The individual must have a minimum of 8 years' experience as a superintendent, inspector, QC Manager, project manager, project engineer or construction manager on similar size and type construction contracts which included the major trades that are part of this Contract. The CQC System Manager must be on the site at all times during construction and must be employed by the prime Contractor. The CQC System Manager must be assigned no other duties. An alternate for the CQC System Manager must be identified in the plan to serve in the event of the System Manager's absence. The requirements for the alternate must be the same as for the designated CQC System Manager.
- C. Additional CQC Personnel: In addition to CQC personnel specified elsewhere in this specification, the Contractor must provide as part of the CQC organization specialized personnel to assist the CQC System Manager in the following areas: civil, architectural, structural, mechanical, electrical, and fire protection. These individuals must:
 - 1. Be directly employed by the prime Contractor or a Quality Control sub-contractor but may not be employed by a supplier or other sub-contractor on this project

2. Be responsible to the CQC System Manager
3. Be on site once a week minimum to support construction activities in their areas of responsibility
4. Have the necessary education and/or experience in accordance with the experience matrix listed herein.
5. These individuals must review all submittals in their areas of responsibility prior to submission to the FAA
6. Witness testing of the activities in their areas of responsibility.
7. These individuals may perform other duties but must be allowed sufficient time to perform their assigned quality control duties as described in the Quality Control Plan.
8. All personnel are subject to FAA approval.

D. EXPERIENCE MATRIX

Area	Qualifications
1. Concrete, Pavements, Utilities and Soils	US Registered Civil Engineer with 2 years related experience
2. Architectural	US Registered Architect with 2 years related experience
3. Structural (Foundations and Structures	US Registered Structural Engineer with 2 years related experience
4. Mechanical	US Registered Mechanical Engineer with 2 years related experience. Required knowledge of HVAC TAB, HVAC DDC and HVAC commissioning.
5. Electrical	US Registered Electrical Engineer with 2 years related experience
6. Fire Protection	US Registered Fire Protection Engineer (FPE) with 2 years related experience

Personnel indicated above must have no business relationships with any subcontractors involved with this project; or with any equipment device manufacturers, suppliers, or installers for any such equipment provided as part of this project.

- E. Organizational Changes: When it is necessary to make changes to the CQC staff, the Contractor must revise the CQC Plan to reflect the changes and submit the changes to the COR for acceptance.

3.5 REQUEST FOR INFORMATION (RFI's) AND SUBMITTALS

- A. Submittals must be made as specified in Section 01 33 00 "SUBMITTAL PROCEDURES". The specialized personnel identified in the Experience Matrix (paragraph 3.4.D) as part of the CQC System must be responsible for reviewing all RFI's and submittals in their areas of responsibility prior to submission to the FAA.

3.6 CONTROL

- A. Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control must be conducted by the CQC System Manager for each definable feature of work as follows:
- B. Preparatory Phase: This phase must be performed prior to beginning work on each definable feature of work; after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase must include:
 - 1. A review of each paragraph of applicable specifications, reference codes, and standards. A copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field must be made available by the Contractor at the preparatory inspection. These copies must be maintained in the field and available for use by Government personnel until final acceptance of the work.
 - 2. A review of the contract drawings.
 - 3. A check to assure that all materials and/or equipment have been tested, submitted, and approved.
 - 4. Review of provisions that have been made to provide required control inspection and testing.
 - 5. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.
 - 6. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.
 - 7. A review of the appropriate activity hazard analysis to assure safety requirements are met.
 - 8. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.
 - 9. A check to ensure that the portion of the plan for the work to be performed has been accepted by the COR.
 - 10. Discussion of the initial control phase.
 - 11. The Government must be notified at least 48 hours in advance of beginning the preparatory control phase. This phase must include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions must be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor must instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.
- C. Initial Phase: This phase must be accomplished at the beginning of a definable feature of work. The following must be accomplished:
 - 1. A check of work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.
 - 2. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.
 - 3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
 - 4. Resolve all differences.

5. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
 6. The Government must be notified at least 24 hours in advance of beginning the initial phase. Separate minutes of this phase must be prepared by the CQC System Manager and attached to the daily CQC report. Exact location of initial phase must be indicated for future reference and comparison with follow-up phases.
 7. The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
- D. Follow-up Phase: Daily checks must be performed to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks must be made a matter of record in the CQC documentation. Final follow-up checks must be conducted, and all deficiencies corrected prior to the start of additional features of work that may be affected by the deficient work. The Contractor must not build upon nor conceal non-conforming work.
- E. Additional Preparatory and Initial Phases: Additional preparatory and initial phases must be conducted on the same definable features of work if: the quality of on-going work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity; or if other problems develop.

3.7 TESTS

- A. Testing Procedure: The Contractor must perform specified or required tests to verify that control measures are adequate to provide a product that conforms to contract requirements. Upon request, the Contractor must furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor must procure the services of an approved testing laboratory or establish an approved testing laboratory at the project site. The Contractor must perform the following activities and record and provide the following data:
1. Verify that testing procedures comply with contract requirements.
 2. Verify that facilities and testing equipment are available and comply with testing standards.
 3. Check test instrument calibration data against certified standards.
 4. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
 5. Results of all tests taken, both passing and failing tests, must be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test must be given. If approved by the COR, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility must be provided directly to the COR. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

B. Testing Laboratories

1. Capability Check: The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel must meet criteria detailed in ASTM D 3740 and ASTM E 329.
2. Capability Recheck: If the selected laboratory fails the capability check, the Contractor will be assessed a charge of \$500 to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

C. Onsite Laboratory: The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

D. Furnishing or Transportation of Samples for Testing: Costs incidental to the transportation of samples or materials must be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Government must be delivered to the Contracting Officer's Representatives office unless otherwise coordinated.

E. Coordination for each specific test, exact delivery location, and dates will be made through the Contracting Officer's Representative.

3.8 DOCUMENTATION

A. The Contractor must maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records must include the work of subcontractors and suppliers and must be on an acceptable form that includes, as a minimum, the following information:

1. Contractor/subcontractor and their area of responsibility.
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.
4. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase must be identified (Preparatory, Initial, Follow-up). List of deficiencies noted, along with corrective action.
5. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.
6. Submittals and deliverables reviewed, with contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. Instructions given/received and conflicts in plans and/or specifications.
10. Contractor's verification statement.

B. These records must indicate a description of trades working on the project; the number of personnel

working; weather conditions encountered; and any delays encountered. These records must cover both conforming and deficient features and must include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form must be furnished to the Government daily within 24 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report must be prepared and submitted for every 7 days of no work and on the last day of a no work period. All calendar days must be accounted for throughout the life of the contract. The first report following a day of no work must be for that day only. Reports must be signed and dated by the CQC System Manager. The report from the CQC System Manager must include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.9 NOTIFICATION OF NONCOMPLIANCE

- A. The COR will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor must take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, must be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the COR may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders must be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

END OF SECTION 01 40 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.2 DEFINITIONS

- A. Permanent Enclosure: As determined by COR, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

1.3 USE CHARGES

- A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Pay water service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.

1.4 SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before FAA's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized steel, chain-link fabric fencing; minimum 8 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts with galvanized barbed-wire top strand.
- B. Portable Chain-Link Fencing: Minimum 2-inch, 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete or galvanized steel bases for supporting posts.
- C. Wood Enclosure Fence: Plywood, 6 feet high, framed with four 2-by-4-inch rails, with preservative-treated wood posts spaced not more than 8 feet apart.
- D. Lumber and Plywood: Comply with requirements in Section 06 10 00 "Rough Carpentry."
- E. Gypsum Board: Minimum 1/2 inch thick by 48 inches wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36/C 36M.
- F. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
- G. Paint: Comply with requirements in Division 09 painting Sections.

2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. FAA Field Representative's Office – See Section 01-50-10.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, FAA, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- C. Heating and cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- D. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- E. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
- F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - 2. Install lighting for Project identification sign.
- G. Telephone Service: Provide temporary telephone service in common-use facilities and FAA field representative's office.

1. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. COR's office.
 - e. Engineers' offices.
 - f. Principal subcontractors' field and home offices.
 2. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- H. Internet Service: Provide internet connection for duration of project in common-use facilities and FAA field representative's office with minimum band width of 1 mb/sec. Internet service will be of sufficient band width, speed etc. to efficiently view, download edit, etc. all BIM files, schedule files, and all contractor deliverables. The contractor shall supply internet service for all FAA and FAA contractor employees working on site. For planning purposes, the contractor will plan for 10 connections to the internet all capable of performing required functions under this contract.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
1. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
 2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to FAA.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations.
1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Provide temporary parking areas for construction personnel.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.

2. Remove snow and ice as required to minimize accumulations.
- F. Project Identification and Temporary Signs: Provide Project identification and other signs as indicated on Drawings and required by law. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
1. Provide temporary, directional signs for construction personnel and visitors.
 2. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.
- H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- I. Temporary Elevator Use: Refer to Division 14 Sections for temporary use of new elevators.
- J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- K. Temporary Use of Permanent Stairs: Cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
1. Comply with work restrictions specified in Section 01 10 00 "Summary of Work."
- B. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for FAA. Perform control operations lawfully, using environmentally safe materials.
- C. Site Enclosure Fence: Before construction operations begin, furnish, and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
1. Extent of Fence: As indicated on Drawings.
 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide FAA with one set of keys.

- D. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- E. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- F. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
- G. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
 - 1. Prohibit smoking in construction areas.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
 - 2. The Contractor and each subcontractor shall be responsible for cleaning and maintaining all temporary offices and storage sheds in proper condition acceptable to the COR. All exposed surfaces on the outside and inside of field offices and temporary toilet enclosures and outside of storage sheds shall be painted and maintained with exterior enamel paint. Colors are subject to approval by the COR. All temporary facilities shall be maintained by the Contractor and shall be kept in usable condition at all times until completion of the work and/or their removal is authorized by the COR.

3. Maintain lighting. Promptly replace worn or defective parts and non-working bulbs.
 4. Maintain temporary water system: Maintain system to provide continuous service with adequate pressure to outlets. Maintain connections, pipes, fittings, and fixtures and conserve use of all utilities. Failure to stop leaks or other waste of water will be cause for revocation of permit for the use of said water from the airport system.
 5. Maintain temporary toilet facilities: clean facilities and surrounding areas daily. Provide toilet paper, paper towels and soap in suitable dispensers.
 6. Maintain erosion, sedimentation, and pollution control measures throughout the project life cycle. Inspect erosion, sedimentation, and pollution control measures once per week and following each rain event. Any deficiencies shall be reported to the COR and promptly corrected within 48-hours.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. FAA reserves right to take possession of Project identification signs.
 2. Consider inserting specific removal requirements, as illustrated in first subparagraph below.
 3. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 4. Remove temporary erosion, sedimentation, and pollution control measures upon final stabilization of site.
 5. Remove temporary lighting material and equipment when permanent system is operational.
 6. Remove temporary toilet facilities when permanent facilities are available for use, but no later than Substantial Completion.

7. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified. in Section 01 77 00 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 50 10 – FAA FIELD REPRESENTATIVE’S OFFICE

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Field Representative's Office.
- B. Maintenance and Janitorial Services and Cleaning.
- C. Removal.

1.2 PERMITS

The Contractor shall apply for and obtain all construction permits and required inspections for this and any other temporary facilities.

1.3 LOCATION

The location of the Field Representative’s trailer must be approved by the RE.

1.4 SUBMITTALS

Provide product data and equipment specifications in accordance with Section 01330.

1.5 TIME OF USE

The Field Representative’s office shall be installed on the site at the time construction begins. It shall remain on site and usable until Final Construction Acceptance Inspection unless an earlier removal date is requested or approved by the RE.

PART 2 PRODUCTS - Not Used.

PART 3 EXECUTION

3.1 FAA’s FIELD REPRESENTATIVE OFFICE

- A. Separate space for sole use of FAA's Field Representative with separate entrance door with new lock and five (5) keys.
- B. Area: Provide floor plan in general conformance with Figure #1.
- C. Windows: Minimum of 5; minimum total area of ten percent (10%) of floor area, with operable sash and insect screens. Locate to provide views of construction area. Windows shall have glass panes and shall be equipped with venetian blinds and latches.
- D. Doors: A minimum of two doors, each at least 2 feet, 8 inches wide, shall be provided. Access steps with an entrance platform and safety hand rail shall be provided for each door. The movable step usually furnished with most office trailers is not acceptable.

- E. Walls: Interior walls shall be furnished with 1/4" minimum thick, durable, prefinished wood paneling, preferably of a dark shade.
- F. Ceilings: Ceilings shall be at least 7 feet high and constructed of acoustical tile.
- G. Floor: Floor covering shall be of asphalt or vinyl tile.
- H. Electrical Distribution Panel: 18 circuits minimum, 240 volt, 60 hz service.
- I. 120 volt duplex convenience outlets, spaced at 12 foot intervals, with a minimum of one per wall in each room.
- J. Switch controlled fluorescent light fixtures, capable of maintaining minimum illumination of 20 foot-candles at desk height.
- K. Telephone Lines: A minimum of 8 lines with one line dedicated to the all in one machine described in paragraph O. Contractor shall provide high speed internet connection, at the highest rate DSL available from any provider in the area, with outlets at each phone location and all in one location. Provide 7 five -line, touch-tone speaker phones including mute function, caller ID, call forwarding etc. Conference room shall have conference call facilities including speaker phone with a main station and two remote microphones. Provide automatic roll-over of incoming and out-going calls. Contractor shall pay for all local phone service. Contractor shall pay long distance service. All service shall be in contractor's name.
- L. Indoor Sanitary Facilities: cold water fountain; toilet; wash basin; mirror; toilet paper, cup, soap and towel dispensers; electric water heater; and waste receptacle. Restroom shall be properly ventilated.
- M. Heating/Cooling: HVAC shall be provided and be of adequate capacity to maintain an inside temperature of 72 degrees F at the local outdoor design temperature.
- N. Furnishings (confirm furnishings with RE):

- Provide Floor mats at all entrances
- Paper shredder

Rooms #1, #2, #4, and #7:

- 1 Desk – 6 drawer type
- 1 Desk chair
- 2 Office chairs
- 1 Tack board
- 1 Dry Erase Board
- 4' Book shelf

Room #3:

- 6 Folding tables (36"x 72")
- 30 Stacking chairs
- 1 Tack board
- 2 Dry Erase Boards

- 1 Secretarial desk
- 1 Water cooler
- 12' Bookshelves (12" x 72")
- 1 Locking Storage cabinet (16" x 36" x 72")
- 2 Drafting stool
- 2 Plan racks – hanging type – 10 sticks each
- 4 3'x6' book shelves. Location to be determined by RE
- 2 Fire rated 4-drawer filing cabinet. Legal size
- 2 Filing cabinets, legal size.

Room #8:

- 2 Desk – 6 drawer type
- 2 Desk chair
- 2 Office chairs
- 1 Tack board
- 4' Book shelf

Break Area:

- 1 Sink with hot and cold water
- 18 cubic foot refrigerator
- 2 cubic foot microwave oven
- 1 Coffee Maker (10 cup, programmable)

1. Fire rated filing cabinets shall be one hour rated. Include lock and not less than 2 keys.
2. Desk chairs shall be metal with leather seat and include: swivel; arms; and casters.
3. Office chairs shall be straight metal chairs with leather seats.
4. Provide one waste basket per room plus two additional in Room #3.
5. Tackboards, 24 inch x 48 inch minimum.
6. 25-person first aid kit (provide replacement supplies as needed).
7. 2½ pound A:B:C: dry-chemical fire extinguisher, minimum 2 each

- O. One all in one machine capable of network printing, network scanner, copier, fax plus all service and supplies including paper and toner, with at least the following features:

1. Capable of normal use of 150,000 copies per month.
2. Plain paper, dry toner type.
3. Capable of reduction from legal to 8-1/2"x11" and 11"x17" to 8-1/2"x11".
4. Capable of 8-1/2"x11" and 11" x 17" multipage, color reproduction.
5. Capable of color printing of 8-1/2" x11" and 11" by 17"
6. Capable of color scanning of 8-1/2" x11" and 11" by 17" and distributing the resulting file via the internal network
7. Print Speed at 35ppm

- P. Desk Top Computer

1. Two (2) IBM compatible 4.5 GHZ minimum Multicore Xeon or i-Series processor or AMD equivalent with SSE2 technology, 16 GB RAM, Gigabit Ethernet Port, 1 TB 10,000 RPM SATA and 20 GB SSD Cache HD, Personal Computer, and V.90 modem with FAX capability, LAN connection, 16X DVD+/-RW. 2 GB

- DirectX 10-capable graphics card with Shader Model 3 as recommended by Autodesk, sound card, and monitor shall be capable of supporting Super VGA resolution. Minimum 27" 1,980 x 1,200 flat panel LCD true color monitor. Computer shall have Windows 7 64-bit Enterprise, Ultimate or Professional Edition already installed. Include required accessories and maintenance for the length of the project.
2. 3 UPS with auto shut down and startup capability and integral Surge suppression. Minimum two USB port, LAN/Ethernet port, phone jack, 4 receptacles, minimum 400 watt capacity.
 3. Software: Latest schedule software to match contractor's, MS Office 2010, MS Internet Explorer 10.0, Autodesk Revit 2014, Autodesk Navisworks Manage 2014, Latest Bentley MicroStation and Autodesk AutoCAD Version CADD (Lite or equivalent acceptable), Security software (Norton or McAfee), and latest version Adobe Acrobat.
- Q. Plotter: D Size network plotter: Provide a color D sized (22"x34") plotter with 1 GB of memory, and capable of printing a high quality plot D sized color plot in less than 20 seconds. Plotter shall accept roll paper. Contractor to provide ink and paper for operation during entire construction period. Shall be connected to the LAN so as to be usable by all computers.
- S. Upon completion of the project the desk-top computer, hand-held devices, printer, plotter, and all software applications shall become the property of FAA.
- T. Network
1. Provide the hub and all wiring needed to set up a network within the building. Network outlets shall be provided in all offices and two network outlets will be provided in the conference room. The network shall connect into the internet.

3.2 PARKING FACILITIES

Provide well drained, graded and paved, or at least well compacted gravel surface for use by the FAA's staff. Provide not less than five parking spaces.

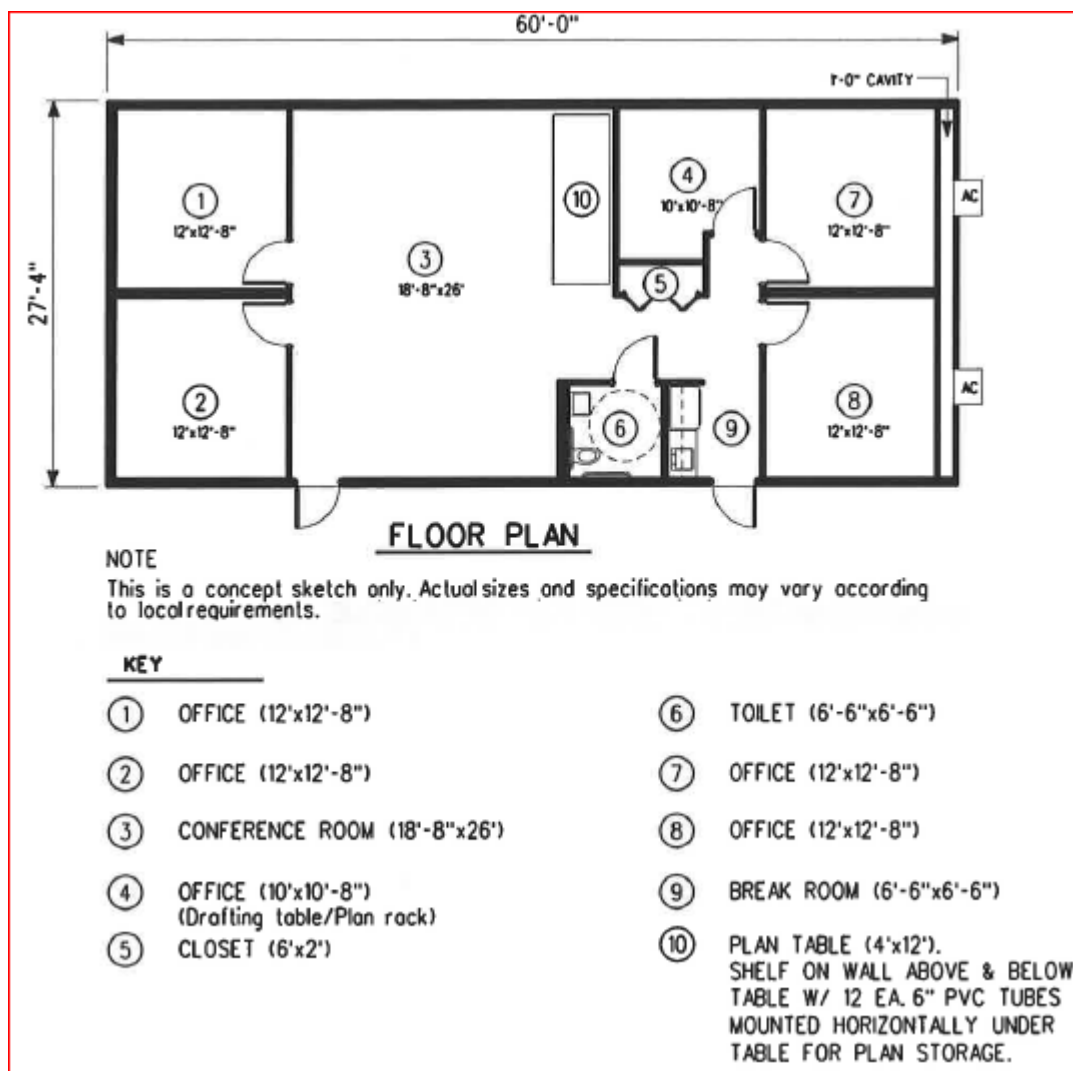
3.3 MAINTENANCE AND CLEANING

- A. Daily janitorial service for offices; periodic cleaning and maintenance for storage areas. Weekly trash collection.
- B. Maintain approach walks free of mud and water.
- C. The Contractor assumes full responsibility for all costs associated with equipment and services provided for the Field Representative's office (including costs for equipment and/or services which are provided by the Contractor, but which are not specifically required by this Article).

3.4 REMOVAL

At final completion of work or earlier if agreed by FAA, remove buildings, foundations, utility services and debris. Restore area.

FIGURE #1



END OF SECTION 01 50 10

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SECTION 01 52 16 - SAFETY REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

a.	ANSI A10.14	Construction and Demolition Operations – Requirements for Safety Belts, Harnesses, Lanyards and Lifelines for Construction and Demolition Use
b.	ANSI Z359.1	Safety Requirements for Personal Fall Arrest Systems

2. CODE OF FEDERAL REGULATIONS (CFR)

a.	29 CFR 1910	General Industry
b.	29 CFR 1910.94	Ventilation
c.	29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
d.	29 CFR 1926	Construction
e.	29 CFR 1926.65	Hazardous Waste Operations and Emergency Response
f.	29 CFR 1926.502(f)	Warning Line Systems
g.	29 CFR 1926.1200	Hazard Communication Standard (MSDS)

3. CORPS OF ENGINEERS (COE)

a.	COE EM-385-1-1	Safety and Health Requirements Manual

4. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a.	NFPA 70	National Electrical Code
b.	NFPA 241	Safeguarding Construction, Alteration, and Demolition Operations. Typical items of inclusion include, but are not limited to: Fire Safety Program, Contractor Requirements, Fire Alarm Reporting, Fire Department Access, Hydrants, Standpipes, Fire Extinguishers and Means of Egress.

1.2 DEFINITIONS

- A. Certified Safety Professional. A safety manager, safety specialist, or safety engineer that has passed the CSP exam administered by the Board of Certified Safety Professionals.
- B. Confined Space. A space which by design has limited openings for entry and exit, unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy, engulfment or any other recognized safety or health

hazard. Confined spaces include, but are not limited to storage tanks, process vessels, pits, silos, vats, degreasers, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines.

- C. Multi-employer work site (MEWS). The prime contractor is the “controlling authority” for all work site safety and health of the subcontractors.
- D. Recordable Occupational Injuries or Illness. An occupational injury or illnesses which result in serious injuries lost workday cases, non-fatal cases or significant mishaps.
- E. Serious Injuries & Fatalities. Regardless of the time between the injury and death or the length of the illness; hospitalization of three or more employees; or property damage in excess of \$200,000.
- F. Lost Workday Cases. Injuries, other than fatalities, that results in lost workdays.
- G. Non-Fatal Cases. Cases without lost workdays which result in transfer to another job or termination of employment or require medical treatment (other than first aid) or involve property damage in excess of \$10,000 but less than \$200,000 or involve: loss of consciousness or restriction of work or motion. This category also includes any diagnosed occupational illnesses which are reported to the employer but are not classified as fatalities or lost workday cases.
- H. Safety Officer. The superintendent or other qualified or competent person who is responsible for the on-site safety required for the project. The contractor quality control person cannot be the safety officer, even though the QC has safety inspection responsibilities as part of the QC duties.
- I. Significant Contractor Mishap. A contractor mishap which involves falls of 4 feet or more, electrical mishaps, confined space mishaps, diving mishaps, equipment mishaps, and fire mishaps which result in a lost time injury, or property damage of \$10,000 or more, but less than \$200,000; or when fire department or emergency medical treatment (EMT) assistance is required.
- J. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment provided by a physician or registered personnel.
- K. First aid. An on-time treatment, and follow-up visit for the purpose of observation, of minor scratches, cuts, burns, splinters, and so forth, which do not ordinarily require medical care, even though provided by a physician or registered professional personnel.
- L. Lost Workdays. The number of days (consecutive or not) after, but not including the day of injury or illness during which the employee would have worked but could not do so; that is, could not perform all or part of his normal assignment during all or any part of the workday or shift; because of the occupational injury or illness.
- M. Environmental Monitoring Services Contractor: Hereafter shall be referred to as the Environmental Contractor, shall be completely independent from the General Contractor and Abatement Contractor and shall not be an employee of the General Contractor or Abatement Contractor or be an employee of principal of a firm recognized by Federal, state, or local regulations that would constitute a business relationship that would be considered independent of the General Contractor or Abatement Contractor Scope of Work.

1.3 SUBMITTALS

A. Statements

1. Accident Prevention Plan (APP): Submit at least 30 calendar days prior to start of work at the job site, follow Appendix A of COE EM-385-1-1, make APP site specific.
2. Activity Hazard Analysis (AHA): Submit the AHA for the preparatory phase as a part of the APP. Submit subsequent AHA for each major phase of work at least 30 calendar days prior to the start of that phase. Format subsequent AHA as amendments to the APP.
3. Health and Safety Plan: The contractor shall develop and implement a comprehensive health and safety plan for his or her employees that cover all aspects of onsite construction operations and activities associated with this contract. This plan must comply with all applicable health and safety regulations and any project-specific requirements that the FAA has specified. The health and safety plan shall include applicable written safety programs in accordance with OSHA regulations.

This includes but not limited to the following.

Safety Management, Fall Protection, Personal Protective Equipment Hazard Evaluation, Confined Space, Trenching, Control of Hazardous Energy (Lockout/Tag out), and Hazard Communication.

Acceptance of the contractor's health and safety plan only signifies that the plan generally conforms to the requirements of the contract. It does not mean that the FAA has verified that the plan meets all applicable OSHA regulations and does not relieve the contractor of the responsibility for providing employees with a safe and healthful work environment. All contract employees must be trained and be familiar with the requirements of the health and safety plan. This concept must be communicated to the contractor by the Contracting Officer and also incorporated into the contract document.

B. Records

1. Daily Confined Space Entry Permit. Submit one copy of each permit attached to each Daily Production Report.
2. Reports. Submit reports as their incidence occurs, in accordance with the requirements of the paragraph entitled, "Reports".

1.4 QUALITY ASSURANCE

A. Qualifications

1. Qualifications of Safety Officer:
 - a. Ability to manage the on-site contractor safety program through appropriate management controls.

- b. Ability to identify hazards and have the capability to expend resources necessary to abate the hazards.
 - c. Must have worked on similar types of projects that are equal to or exceed the scope of the project assigned with the same responsibilities.
- 2. Qualifications of Qualified Person, Confined Space Entry. The qualified person shall be capable (by education and specialized training) of anticipating, recognizing, and evaluating employee exposure to hazardous substances or other unsafe conditions in a necessary control and protective action to ensure worker safety.

B. Meetings

- 1. Preconstruction Conference: The safety officer shall attend the preconstruction conference to discuss work procedures and safety.
- 2. Weekly Safety Meetings: Hold weekly. Provide minutes showing contract title, signatures of attendees and a list of topics discussed.

1.5 ACCIDENT PREVENTION PLAN (APP)

- A. Prepare the APP in accordance with the required and advisory provisions of COE EM-385-1-1 including appendix A, "Minimum Basic Outline for Preparation of Accident Prevention Plan," and as modified herein. Include the associated AHA and other specific plans, programs and procedures listed on Pages A-3 and A-4 of COE EM-385-1-1, some of which are called out below.

B. Contents of the Accident Prevention Plan:

- 1. Name and safety related qualifications of safety officer (including training and any certifications).
- 2. Qualifications of competent and of qualified persons.
- 3. Identify the individual who will complete exposure data (hours worked); accident investigations, reports, and logs; and immediate notification of accidents to include subcontractors.
- 4. Emergency response plan. Conform to COE EM-385-1-1, paragraph 01.E and include a map denoting the route to the nearest emergency care facility with emergency phone numbers. Contractor may be required to demonstrate emergency response.
- 5. Confined Space Entry Plan. Identify the qualified person's name and qualifications, training, and experience. Delineate the qualified person's authority to direct work stoppage in the event of hazardous conditions. Include procedure for rescue by contractor personnel and the coordination with emergency responders. (If there is no confined space work, include a statement that no confined space work exists, and none will be created.)
- 6. Hazardous Material Use. Provisions to deal with hazardous materials, pursuant to the Contract Clause "AMS 52.223-3, Hazardous Material Identification and Material Safety Data." And the following:
 - a. Inventory of hazardous materials to be introduced to the site with estimated quantities.
 - b. Plan for protecting personnel and property during the transport, storage and use of the materials.

- c. Emergency procedures for spill response and disposal, including a site map with approximate quantities on site at any given time. The site map will be attached to the inventory, showing where the hazardous substances are stored.
 - d. Material Safety Data Sheets for inventoried materials not required in other section of this specification.
 - e. Labeling system to identify contents on all containers on-site.
 - f. Plan for communicating high health hazards to employees and adjacent occupants.
- 7. Hazardous Energy Control Plan. For hazardous energy sources, comply with COE EM-385-1-1, paragraph 12.A.07.
- 8. Critical Lift Procedures. Weight handling critical lift plans will be prepared and signed in accordance with COE EM-385-1-1, paragraph 16.c.18.
- 9. Alcohol and Drug Abuse Plan
 - a. Describe plan for testing with pre-employment screening in accordance with the AMS Clause 3.6.3-16.
 - b. Description of the on-site prevention program.
- 10. Fall Protection Plan. The plan shall be site specific and protect all workers at elevations above 6 feet.
- 11. Silica Exposure Reduction. The plan shall include specific procedures to prevent employee silica inhalation exposures.
- 12. Air Quality Monitoring Plan. The Air Quality Monitoring Plan shall be approved by the Environmental Contractor prior to submittal to the FAA. The plan shall include proposed air quality monitoring equipment, contaminants to be measured with maximum concentration limits, and proposed controls and mitigation as appropriate to the Project.

1.6 ACTIVITY HAZARD ANALYSIS (AHA)

- A. Prepare for each phase of the work. As a minimum, define activity being performed, sequence of work, specific hazards anticipated, control measures to eliminate or reduce each hazard to acceptable levels, training requirements for all involved, and the competent person in charge of that phase of work. For work with fall hazards, including fall hazards associated with scaffold erection and removal, identify the appropriate fall arrest systems. For work with materials handling equipment, address safeguarding measures related to materials handling equipment. For work requiring excavations, include excavation safeguarding requirements. The appropriate AHA shall be reviewed and attendance documented by Contractor at the preparatory, initial, and follow-up phases of Quality Control inspection.

1.7 DRUG PREVENTION PROGRAM

- A. Conduct a proactive drug and alcohol use prevention program for all workers, prime and subcontractor, on the site. Ensure that no employees either use illegal drugs or consume alcohol during work hours. Ensure no employees under the influence of drugs or alcohol during work hours. After accidents, collect blood, urine or saliva specimens and test injured employee influence. A copy of the test shall be made available to the RE upon request.

1.8 FALL HAZARD PREVENTION PROGRAM

- A. Scaffolds: A competent person shall delineate the fall protection requirements necessary during the erection and dismantling operation of scaffolds used on the project in the fall protection plan and activity hazard analysis for the phase of work.
- B. Training: A competent person shall institute a fall protection program. As part of the Fall Protection Program, contractor shall provide training for each employee who might be exposed to fall hazards.

1.9 DUTIES OF THE SAFETY OFFICER

- A. Ensure construction hazards are identified and corrected.
- B. Maintain applicable safety reference material on the job site.
- C. Maintain a log of safety inspections performed.
- D. Attend the pre-construction conference.
- E. Generate and approve agenda for safety meetings.

1.10 DISPLAY OF SAFETY INFORMATION

- A. Display the following information in clear view of the on-site construction personnel:
 - 1. Map denoting the route to the nearest emergency care facility with emergency phone numbers.
 - 2. AHA
 - 3. Confined space entry permit.

1.11 SITE SAFETY REFERENCE MATERIALS

- A. Maintain safety-related references applicable to the project, including those listed in the article “References”. Maintain applicable equipment manufacturers’ manuals.

1.12 HIGH HAZARD WORK AND LONG DURATION

- A. Work under this contract is potentially hazardous. Pursuant to contract clause “AMS 52.236-13, Accident Prevention, Alternate I,” submit in writing additional proposals for effecting accident prevention under hazardous conditions. Meet in conference with COR to discuss and develop mutual understanding relative to the administration of the overall safety program.

1.13 EMERGENCY MEDICAL TREATMENT

- A. Contractors shall arrange for their own emergency medical treatment. FAA has no responsibility to provide.

1.14 REPORTS

- A. Reporting Reports: For OSHA recordable accidents, the prime contractor will conduct a suitable investigation, complete the Contractor Significant Incident Report (CSIR) form and provide to the COR within 5 calendar days of the accident.
- B. Notification: Notify COR, within 4 hours of any accident meeting the definition of OSHA recordable occupational injury or illness. Information shall include Contractor name; contract title; type of contract; name of activity, installation, or location where mishap occurred; date and time of mishap; names of personnel injured; extent of property damage, if any; and brief description of mishap (to include type of construction equipment used, participants, etc.). In addition to OSHA reporting requirements, initial notification shall be made of any accident involving significant mishaps.
- C. Monthly Exposure Report: Monthly exposure reporting, to the COR is required to be attached to the monthly billing request. This report is a compilation of employee-hours worked each month for all site workers, both prime and subcontractor.
- D. OSHA Citations and Violations: Provide the COR with a copy of each OSHA citation, OSHA report and Contractor response. Correct violations and citations promptly and provide written corrective actions to the COR.

PART 2 - PRODUCTS

2.1 FALL PROTECTION ANCHORAGE

- A. Fall protection anchorages, used by contractors to protect their people, will be left in place and so identified for continued customer use.

2.2 CONFINED SPACE SIGNAGE

- A. Provide permanent signs integral to or securely attached to access covers for new confined spaces. Signs wording: “DANGER—PERMIT REQUIRED CONFINED SPACE – DO NOT ENTER –“ on bold letters a minimum of one inch in height and constructed to be clearly legible with all paint removed. The signal word “DANGER” and shall be red and readable from 5 feet.

PART 3 - EXECUTION

3.1 CONSTRUCTION

- A. Comply with COE EM-385-1-1, NFPA 241, the accident prevention plan, the activity hazard analysis and other related submittals and activity fire and safety regulations.
- B. Hazardous Material Exclusions: Notwithstanding any other hazardous material used in this contract, radioactive materials or instruments capable of producing ionizing/non-ionizing radiation as well as materials which contain asbestos, mercury or polychlorinated biphenyls, di-isocyanates,

lead-based paint are prohibited. Exceptions to the use of any of the above excluded materials may be considered by COR upon written request by Contractor.

- C. Unforeseen Hazardous Material: If material that may be hazardous to human health upon disturbance during construction operations is encountered, stop that portion of work and notify the COR immediately. Within 14 calendar days the COR will determine if the material is hazardous. If material is not hazardous or poses no danger, the COR will direct the Contractor to proceed without change. If material is hazardous and handling of the material is necessary to accomplish the work, the COR will issue a modification pursuant to “AMS 52.243-4, Changes” and “AMS 52.236-2, Differing Site Conditions”.

3.2 PRE-OUTAGE COORDINATION MEETING

- A. Contractors are required to apply for utility outages a minimum of 15 days in advance. As a minimum, the request should include the location of the outage, utilities being affected, duration of outage and any necessary sketches. Once approved and prior to beginning work on the utility system requiring shut down, the Contractor shall attend a pre-outage coordination meeting with the COR to review the scope of work and the lock out/tag out procedures for work protection.

3.3 PERSONNEL PROTECTION

- A. Hazardous Noise: Provide hazardous noise signs, and hearing protection, wherever equipment and work procedures produce sound-pressure levels greater than 85 dBA steady state or 140 dBA impulse, regardless of the duration of the exposure.
- B. Fall Protection: Enforce use of the fall protection device named for each activity in the AHA all times when an employee is on a surface 6 feet or more above lower levels. Personal fall arrest systems are required when working from an articulating or extendible boom, scissor lifts, swing stages, or suspended platform. Fall protection must comply with ANSI A10.14.
 - 1. Personal Fall Arrest Device: Equipment, subsystems and components shall meet ANSI Z359.1, Personal Fall Arrest Systems. Only a full-body harness with a shock absorbing lanyard is an acceptable personal fall arrest device. Body belts may only be used as positioning devices only such as for steel reinforcing assembly. Body belts are not authorized as a personal fall arrest device. Harnesses must have upper middle back “D” rings for proper body suspension during a fall. Lanyard must be fitted with a double locking snap hook attachment. Webbing, straps, and ropes must be of synthetic fiber or wire rope.
 - 2. Fall Protection for Roofs:
 - a. For work within 6 feet of an edge, on low pitched roofs, personnel shall be protected by use of personal fall arrest systems, guardrails, safety nets. Safety monitoring system is not adequate fall protection and is not authorized.
 - b. For work greater than 6 feet from an edge, warning lines shall be erected and installed in accordance with 29 CFR 1926.502(f).
 - 3. Safety Nets: Safety nets shall be provided in unguarded workplaces more than 25 feet above surface.

- C. Scaffolding: Employees shall be provided with a safe means of access to the work area on the scaffold. Climbing on any scaffold braces or supports not specifically designed for access is prohibited. Contractor shall ensure that scaffold erection is performed by employees that are qualified. Do not use scaffold without the capability of supporting at least four times the maximum intended load or without appropriate fall protection as delineated in the accepted fall protection plan. Minimum platform size shall be based on the platform not being greater in height than four times the dimension of the smallest width dimension for rolling scaffold. Some Baker type scaffolding has been found not to meet these requirements. Stationary scaffolds must be attached to structural building components to safeguard against tipping forward or backward. The first tie-in shall be at the height equal to 4 times the width of the scaffold base.
- D. Use of Material Handling Equipment
 - 1. Material handling equipment such as forklifts shall not be modified with work platform attachments for supporting employees unless specifically delineated in the manufacturers printed operating instructions. Crane supported work platforms shall only be used in extreme conditions if the Contractor proves that using any other access to the work location would provide a greater hazard to the workers.
 - 2. Cranes must be equipped with Load Indicating Devices, anti-two blocks' devices, load and boom angle moment indicating indicators.
- E. Excavations: The competent person for excavation shall be on site when work is being performed in excavation and shall inspect excavations prior to entry by workers. Individual must evaluate for all hazards, including atmospheric, necessary to correct hazards promptly.
- F. Conduct of Electrical Work: Underground electrical spaces must be certified safe for entry before entering to conduct work. Cable intended to be cut must be positively identified and de-energized prior to performing each cut. Perform all high voltage cutting remotely. When racking in or live switching of circuit breakers, no additional person other than the switch operator will be allowed in the space during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method. When working in energized substations, only qualified electrical workers shall be permitted to enter. When work requires Contractor to work near energized circuits as defined by the NFPA 70, high voltage personnel must use personnel protective equipment that includes, as a minimum, electrical hard hat, safety shoes, insulating gloves with leather protective sleeves, fire retarding shirts, coveralls, face shields, and safety glasses. Insulating blankets, hearing protection, and switching suits may be required, depending on the specific job and as delineated in the Contractor AHA.
- G. Work in Manholes: Contractor shall provide mechanical ventilation for all work accomplished in manholes, unless other hazards are present like friable asbestos.
- H. Work in Confined Spaces: Comply with the requirements in Section 06.I of COE EM-385-1-1. Any potential for a hazard in the confined space requires a permit system to be used.
 - 1. Entry Procedures. Prohibit entry into a confined space by personnel for any purpose, including hot work, until the qualified person has conducted appropriate tests to ensure the confined or enclosed space is safe for the work intended and that all potential hazards are

controlled or eliminated and documented. (See Section 06.I.05 of COE EM-385-1-1 for entry procedures.) All hazards pertaining to the space shall be reviewed with each employee during review of the AHA.

2. Forced air ventilation is required for all confined space entry operations and the minimum air exchange requirements must be maintained.
3. Ensure the use of rescue and retrieval devices in confined spaces greater than 5 feet in depth. Conform to Sections 06.I.09, 06.I.10 and 06.I.11 of COE EM-385-11.
4. Include training information for employees who will be involved as entrant attendants for the work. Conform to Section 06.I.06 of COE EM-385-1-1.
5. Entry Permit. Use ENGFORM 5044-R or other form with the same minimum information for the Daily Confined Space Entry Permit, completed by the qualified person. Post the permit in a conspicuous place close to the confined space entrance.

- I. Crystalline Silica: Grinding, abrasive blasting, and foundry operations of construction materials containing crystalline silica, shall comply with OSHA regulations, such as 29 CFR 1910.94, and COE EM-385-1-1, (Appendix C). The Contractor shall develop and implement effective exposure control and elimination procedures to include dust control systems, engineering controls, and establishment of work area boundaries, as well as medical surveillance, training, air monitoring, and personal protective equipment.

3.4 ACCIDENT SCENE PRESERVATION

- A. For serious accidents, ensure the accident site is secured and evidence is protected remaining undisturbed until released by the COR. After release is issued, promptly replace used, damaged, or worn equipment.

END OF SECTION 01 52 16

SECTION 01 56 23 - BARRIERS AND ENCLOSURES

PART 1 - GENERAL

1.1 REQUIREMENT INCLUDED

- A. Barriers
- B. Protected Walkways
- C. Security Fencing
- D. Tree and Plant Protection.
- E. Weather Closures
- F. Partition and Ceiling Enclosures
- G. Maintenance
- H. Removal
- I. Site Restoration

PART 2 - PRODUCTS

1.2 MATERIALS

- A. May be new or used as may be dictated by all governing codes, adequate to the purpose, which will not create hazardous conditions.

PART 3 - EXECUTION

1.3 MARKING FOR HAZARDS

- A. Furnish, erect, and maintain all barricades, warning signs and markings for hazards necessary to protect the public and the work. When used during periods of darkness, such barricades, warning signs and hazard markings shall be suitably illuminated.
- B. Furnish, erect, and maintain markings and associated lighting of open trenches, excavations, temporary stockpiles, and parked construction equipment that may be hazardous to the operation of emergency fire-rescue or maintenance vehicles on the airport in reasonable conformance to FAA Advisory Circular 150/5370-2F, Operational Safety on Airports during Construction.

3.2 BARRIERS AND PROTECTED WALKWAYS

- A. Provide to prevent public entry, to protect existing trees and plants, and to protect existing facilities and adjacent properties from damage.
- B. Provide fence enclosing construction area of height and type required to maintain site security.

3.3 TREE AND PLANT PROTECTION (Not Applicable)

3.4 WEATHER CLOSURES - AS NEEDED

- A. Provide temporary roofing and weathertight insulated closures of openings in exterior surfaces to maintain specified working conditions to protect products and finished work from inclement weather.

3.5 PARTITIONS AND CEILING ENCLOSURES

- A. Temporary construction of this type is not anticipated.

3.6 MAINTENANCE

- A. Maintain during progress of work. Repaint painted surfaces as directed by the COR.
- B. Relocate and extend during successive stages of construction.

3.7 REMOVAL

- A. Remove temporary materials, equipment, and construction at Final Acceptance. Repair or replace damage caused by installation or use of barricades and enclosures. Remove fence post setting.

3.8 SITE RESTORATION

- A. Restore site and existing facilities to remain but damaged during construction to specified condition.

END OF SECTION 01 56 23

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SECTION 01 57 19 - TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. CODE OF FEDERAL REGULATIONS (CFR)

a.	29 CFR 1910	Occupational Safety and Health Standards
b.	40 CFR 122.26	EPA National Pollutant Discharge Elimination System Permit Regulations
c.	40 CFR 241	Guidelines for Disposal of Solid Waste
d.	40 CFR 243	Guidelines for the Storage and Collection of Residential, Commercial, and Institutional Solid Waste
e.	40 CFR 258	Subtitle D Landfill Requirements
f.	40 CFR 261	Identification and Listing of Hazardous Waste
g.	40 CFR 262	Generators of Hazardous Waste
h.	40 CFR 263	Transporters of Hazardous Waste
i.	40 CFR 264	Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
j.	40 CFR 265	Interim Status Standard for Owners and Operators of Hazardous Waste Management Facilities
k.	40 CFR 266	Management of Specific Hazardous Waste and Specific Types of Hazardous Waste Management Facilities
l.	40 CFR 268	Land Disposal Restrictions
m.	40 CFR 279	Used Oil Regulations
n.	40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
o.	40 CFR 372	EPA Toxic Chemical Release Reporting
	SUBPART D	Regulations
p.	49 CFR 173	Shipments and Packaging's

2. ENVIRONMENTAL PROTECTION AGENCY (EPA)

a.	EPA 832-R-92-005	Storm Water Management for Construction Activities

1.2 DEFINITIONS

- A. Sediment: Soil and other debris that has eroded and has been transported by runoff water or wind.
- B. Solid Waste: Garbage, refuse, debris, sludge or other discharged material (except hazardous waste as defined in paragraph entitled "Hazardous Waste" or hazardous debris as defined in paragraph entitled "Hazardous Debris"), including solid, liquid, semisolid, or contained gaseous materials

resulting from domestic, industrial, commercial, mining, or agricultural operations. Material not regulated as solid waste are nuclear source or byproduct materials regulated under the Federal Atomic Energy Act of 1954 as amended; suspended or dissolved materials in domestic sewage effluent or irrigation return flows, or other regulated point source discharges; regulated air emissions; and fluids or wastes associated with natural gas or crude oil exploration or production.

- C. Green waste: The vegetative matter from landscaping, land clearing and grubbing, including, but not limited to, grass bushes, scrubs, small trees and saplings, tree stumps and plant roots. Marketable trees, grasses and plants that are indicated to remain, be re-located, or be re-used are not included.
- D. Surplus soil: Existing soil that is in excess of what is required for this work, including aggregates intended, but not used, for on-site mixing of concrete, mortars and paving. Contaminated soil meeting the definition of hazardous material or hazardous waste is not included.
- E. Inert construction and demolition debris: Broken or removed concrete, masonry, and rock asphalt paving; ceramics; roofing paper and shingles. All in accordance with state requirements.
- F. Wood: Dimension and non-dimension lumber, plywood, chipboard, hardboard. Treated and/or painted wood that meets the definition of lead contaminated or lead based contaminated paint is not included.
- G. Scrap metal: Scrap and excess ferrous and non-ferrous metals such as reinforcing steel, structural shapes, pipe and wire that are recovered or collected and disposed of as scrap. Scrap metal meeting the definition of hazardous material or hazardous waste is not included.
- H. Paint cans: Metal cans that are empty of paints, solvents, thinners, and adhesives. If permitted by the paint can label, a thin dry film may remain in the can.
- I. Recyclables: Materials, equipment, and assemblies such as doors, windows, door and window frames, plumbing fixtures, glazing and mirrors that are recovered and sold as recyclable. Metal meeting the definition of lead contaminated or lead based paint contaminated must be disposed in accordance with state requirements.
- J. Debris: Non-hazardous solid material generated during the construction, demolition, or renovation of a structure which exceeds 2.5-inch particle size that is: a manufactured object; plant or animal matter; or natural geologic material (e.g., cobbles and boulders). A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if the mixture is comprised primarily of debris by volume, based on visual inspection.
- K. Hazardous Debris: As defined in paragraph entitled “Debris” of this section, debris that contains listed hazardous waste (either on the debris surface, or in its interstices, such as pore structure) per 40 CFR 261; or debris that exhibits a characteristic of hazardous waste per 40 CFR 261.
- L. Chemical Wastes: This includes salts, acids, alkalis, herbicides, pesticides, and organic chemicals.
- M. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

- N. Hazardous Waste: Hazardous waste as defined in 40 CFR 261 or as defined by applicable state and local regulations.
- O. Oily Waste: Petroleum products and bituminous materials.
- P. Class I Ozone Depleting Substance (ODS)
 - 1. Class I ODS is defined in Section 602(a) of The Clean Air Act and includes the following chemicals:

Chlorofluorocarbon-11 (CFC-11)	Chlorofluorocarbon-213 (CFC-213)
Chlorofluorocarbon-12 (CFC-12)	Chlorofluorocarbon-214 (CFC-214)
Chlorofluorocarbon-13 (CFC-13)	Chlorofluorocarbon-215 (CFC-215)
Chlorofluorocarbon-111 (CFC-111)	Chlorofluorocarbon-216 (CFC-216)
Chlorofluorocarbon-112 (CFC-112)	Chlorofluorocarbon-217 (CFC-217)
Chlorofluorocarbon-113 (CFC-113)	Halon-1211
Chlorofluorocarbon-114 (CFC-114)	Halon-1301
Chlorofluorocarbon-115 (CFC-115)	Halon-2402
Chlorofluorocarbon-211 (CFC-211)	Carbon tetrachloride
Chlorofluorocarbon-212 (CFC-212)	Methyl chloroform

1.3 SUBMITTALS

A. Statements

- 1. Environmental Protection Plan (see Section 1.6 for detailed requirements).
- 2. Dirt and Dust Control Plan
 - a. Dirt and Dust Control Plan: Submit truck and material haul routes along with a plan for controlling dirt, debris, and dust on base roadways. As a minimum, identify in the plan the subcontractor and equipment for cleaning along the haul route and measures to reduce dirt, dust, and debris from roadways.

B. Field Test Reports

- 1. Laboratory Analysis
 - a. Submit a copy of a laboratory analysis of solid waste and debris with the potential of becoming classified as a hazardous waste (i.e., abrasive/sand blasting debris, etc.). Waste stream determinations are required at the point of generation and must sufficiently document whether the waste will be a solid waste, hazardous waste, or Resource Conservation and Recovery Act (RCRA) exempt waste. Determinations must use EPA approved methods and provide written rationale for whether the waste is classified as hazardous or non-hazardous. The Contractor shall bear the cost of the waste stream determinations, and the COR reserves the right to request waste stream determinations on questionable waste streams.

C. Records

1. Some of the records listed below are also required as part of other submittals. For the “Records” submittal, maintain on-site a separate three-ring Environmental Records binder and submit at the completion of the project. Make separate parts to the binder corresponding to each of the applicable sub items listed below.
 - a. Preconstruction survey
 - b. Solid waste disposal permit
 - c. Waste determination documentation
 - d. Disposal documentation for hazardous and regulated waste
 - e. Regulatory notification
 - f. Erosion and sediment control inspection reports
 - g. Solid waste disposal report
2. Preconstruction Survey: Perform a preconstruction survey of the project site with the COR and take photographs showing existing environmental conditions in and adjacent to the site. Submit a report for the record.
3. Solid Waste Disposal Permit: Submit one copy of a permit or license showing such agency’s approval of the disposal plan before transporting wastes off Government property.
4. Waste Determination Documentation: The Contractor shall complete a Waste Determination form (provided at the pre-construction conference) for all contractor derived wastes to be generated. The waste determination must be based upon either a constituent listing from the manufacturer used in conjunction with consideration of the process by which the waste was generated, EPA approved analytical data, or laboratory analysis (Material Safety Data Sheets (MSDS) by themselves are not adequate). All support documentation must be attached to the Waste Determination form. As a minimum, a Waste Determination form must be provided for the following wastes (this listing is not all inclusive): oil and latex based painting and caulking products, solvents, adhesives, aerosols, petroleum products, and all containers of the original materials.
5. Disposal Documentation for Hazardous and Regulated Waste: Submit a copy of the applicable EPA and state permit(s), manifest(s), or license(s) for transportation, treatment, storage, and disposal of hazardous and regulated waste by permitted facilities.
6. Regulatory Notification: The Contractor is responsible for all regulatory notification requirements in accordance with Federal, state, and local regulations. The Contractor shall forward copies to the COR prior to commencement of work activities. Typically, regulatory notifications must be provided for the following (this listing is not all inclusive): demolition, renovation, NPDES defined site work, remediation of controlled substances (asbestos, hazardous waste, lead paint).
7. Solid Waste Disposal Report: Monthly the Contractor shall submit a solid waste disposal report to the COR. For each waste, the report shall state the classification (using the definitions provided in this section), amount, location, and name of the business receiving the solid waste. The Contractor shall include copies of the waste handling facilities’ weight tickets, receipts, bills of sale, and other sales documentation. In lieu of sales documentation, the Contractor may submit a statement indicating the disposal location for the solid waste which is signed by an officer of the Contractor firm authorized to legally obligate or bind the firm. The sales documentation or Contractor certification shall include the receiver’s tax identification number and business, EPA, or state registration number, along with the receiver’s delivery and business address and telephone numbers. For each solid waste retained by the Contractor for his own use, the Contractor shall submit on the solid waste

disposal report the information previously described. Prices paid or received shall not be reported to the COR unless required by other provisions or specifications of this Contract or public law.

1.4 CLASS I ODS PROHIBITION

- A. Class I ODS as defined and identified herein shall not be used in the performance of this contract, nor be provided as part of the equipment. This prohibition shall be considered to prevail over any other provision, specification, drawing, or referenced documents.

1.5 ENVIRONMENTAL PROTECTION REQUIREMENTS

- A. Provide and maintain, during the life of the contract, environmental protection as defined. Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project. Comply with Federal, state, and local regulations pertaining to the environment, including water, air, solid waste, hazardous waste and substances, oily substances, and noise pollution.
- B. Licenses and Permits: Obtain licenses and permits pursuant to the “Permits and Responsibilities” AMS Clause.
- C. Contractor Liabilities for Environmental Protection: The Contractor is advised that this project and the facility are subject to federal, state, and local regulatory agency inspections to review compliance with environmental laws and regulations. The Contractor shall fully cooperate with any representative from and federal, state, and local regulatory agency who may visit the job site and shall provide immediate notification to the COR, who shall accompany them on any subsequent site inspections. The Contractor shall complete, maintain, and make available to the COR, station, or regulatory agency personnel all documentation relating to environmental compliance under applicable federal, state, and local laws and regulations. The Contractor shall immediately notify the COR if a Notice of Violation (NOV) is issued to the Contractor.
- D. The Contractor shall be responsible for all damages to persons or property resulting from Contractor fault or negligence as well as for the payment of any civil fines or penalties which may be assessed by any federal, state, or local regulatory agency as a result of the Contractor’s or any subcontractor’s violation of any applicable federal, state, or local environmental law or regulation. Should a Notice of Violation (NOV), Notice of Noncompliance (NON), Notice of Deficiency (NOD), or similar regulatory agency notice be issued to the FAA or FAA as facility owner/operator on account of the actions or inactions of the Contractor or one of its subcontractors in the performance of work under this contract, the Contractor shall fully cooperate with the FAA and/or FAA in defending against regulatory assessment of any civil fines or penalties arising out of such actions or inactions.

E. Prevention of Releases to the Environment

1. Procedures to prevent releases to the environment
2. Notifications in the event of a release to the environment

F. Protection of the Environment from Waste (Hazardous Waste Management Section)

1. Control and disposal of solid and sanitary waste
2. Control and disposal of hazardous waste (Hazardous Waste Management Section)
This item shall consist of the management procedures for all hazardous waste to be generated. As a minimum, include the following:
 - a. Procedures to be employed to ensure a written waste determination is made for appropriate wastes which are to be generated,
 - b. Sampling/analysis plan,
 - c. Methods of hazardous waste accumulation/storage (i.e., in tanks and/or containers),
 - d. Management procedures for storage, labeling, transportation, and disposal of waste (treatment of waste is not allowed unless specifically noted),
 - e. Management procedures and regulatory documentation ensuring disposal of hazardous waste complies with Land Disposal Restrictions (40 CFR 268),

- f. Management procedures for recyclable hazardous materials such as lead-acid batteries, used oil, and the like;
 - g. Used oil management procedures in accordance with 40 CFR 279;
 - h. Pollution prevention/hazardous waste minimization procedures;
 - i. Plans for the disposal of hazardous waste by permitted facilities;
 - j. Procedures to be employed to ensure all required employee training records are maintained.
- G. Environmental Protection Plan Review: Fourteen days after the environmental protection meeting, submit the proposed Environmental Protection Plan for further discussion, review, and approval. Commencement of work shall not begin until the environmental protection plan has been approved.

1.6 UNFORESEEN HAZARDOUS OR REGULATED MATERIAL

- A. If material that is not indicated in the contract documents is encountered that may be dangerous to human health upon disturbance during construction operations, stop that portion of work and notify the COR immediately. Intent is to identify materials such as PCB, lead paint, mercury, petroleum products, and friable and nonfriable asbestos. Within 14 calendar days the FAA will determine if the material is hazardous. If the material is not hazardous or poses no danger, the FAA will direct the Contractor to proceed without change. If the material is hazardous and handling of the material is necessary to accomplish the work, the FAA will issue a modification pursuant of “AMS 52.243-4, Changes” and “AMS 52.236-2, Differing Site Conditions”.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 PROTECTION OF NATURAL RESOURCES

1. Water Resources

- a. Oily and Hazardous Substances: Prevent oily or other hazardous substances from entering the ground, drainage areas, or local bodies of water. For oil, fuel oil, or other hazardous substance spills, verbally notify the COR immediately. Surround all temporary fuel oil or petroleum storage tanks with a temporary earth beam of sufficient size and strength to contain the contents of the tanks in the event of leakage or spillage.
2. Fish and Wildlife Resources: Do not disturb fish and wildlife. Do not alter water flows or otherwise significantly disturb the native habitat adjacent to the project and critical to the survival of fish and wildlife, except as indicated or specified.

3.2 CONTROL AND DISPOSAL OF SOLID WASTES

- A. Pick up solid wastes, and place in covered containers which are regularly emptied. Do not prepare or cook food on the project site. Prevent contamination of the site or other areas when handling and disposing of wastes. At project completion, leave the areas clean. Recycling is encouraged and can be coordinated with the COR and the activity recycling coordinator. Remove all solid waste (including non-hazardous debris) from FAA property and dispose off-site at an approved landfill. Solid waste disposal off-site must comply with most stringent local state, and federal requirements including 40 CFR 241, 40 CFR 243, and 40 CFR 258.
- B. Dumpsters: Equip dumpsters with a secure cover. Keep cover closed at all times, except when being loaded with trash and debris. Locate dumpsters behind the construction fence or out of the public view. Empty site dumpsters at least once a week or as needed to keep the site free of debris and trash. If necessary, provide 55-gallon trash containers to collect debris in the construction site area. Locate the trash containers behind the construction fence or out of the public view. Empty trash containers at least once a day. For large demolitions, large dumpsters without lids are acceptable but should not have debris higher than the sides before emptying.

3.3 CONTROL AND DISPOSAL OF HAZARDOUS WASTES

- A. Hazardous Waste/Debris Management: The Contractor shall identify all construction activities that will generate hazardous waste/debris. The Contractor must provide a documented waste determination for all resultant waste streams. Hazardous waste/debris shall be identified, labeled, handled, stored, and disposed of in accordance with all Federal, State and local regulations including 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268. Hazardous waste shall also be managed in accordance with the approved Hazardous Waste Management Section of the Environmental Protection Plan. Store hazardous wastes in approved containers in accordance with 49 CFR 173. Hazardous waste generated within the confines of the facilities shall be identified as being generated by the Contractor. Prior to removal of any hazardous waste from FAA property, all hazardous waste manifests must be signed by the Contractor and a copy given to the COR. No hazardous waste shall be brought onto FAA's property. Provide to the COR a copy of waste determination documentation for any solid waste streams that have any potential to be hazardous waste or contain any chemical constituents listed in 40 CFR 372-SUBPART D. For hazardous wastes spills, verbally notify the COR immediately.

1. Regulated Waste Storage/Satellite Accumulation/90 Day Storage Areas: If the work requires the temporary storage/collection of regulated or hazardous wastes, the Contractor may request the establishment of a Regulated Waste Storage Area, a Satellite Accumulation Area, or a 90 Day Storage Area at the point of generation. The Contractor must submit a request in writing to the COR providing the following information:

Contract Number	_____	Contractor	_____
Haz/Waste or Regulated Waste POC	_____	Phone Number	_____
Type of Waste	_____	Source of Waste	_____
Emergency POC	_____	Phone Number	_____
Location of the Site	_____		

(Attach Site Plan to the Request)

2. Attach a waste determination form. Allow ten working days for processing this request.
- B. Pollution Prevention/Hazardous Waste Minimization: The Contractor shall actively pursue minimizing the use of hazardous materials and the generation of hazardous waste while on-base. The Hazardous Waste Management Section of the Environmental Protection Plan shall include the Contractor's procedures for pollution prevention/hazardous waste minimization. The Contractor shall describe the types of the hazardous materials expected to be used in the construction when requesting information.
- C. Hazardous Material Control: The Contractor shall include hazardous material control procedures in the Safety Plan. The procedures shall address and ensure the proper handling of hazardous materials, including the appropriate transportation requirements. The Contractor shall submit a MSDS and estimated quantities to be used for each hazardous material to the COR prior to bringing the material on base. Typical materials requiring MSDS, and quantity reporting include, but are not limited to, oil and latex based painting and caulking products, solvents, adhesives, aerosol, and petroleum products. At the end of the project, the Contractor shall provide the COR with the maximum quantity of each material that was present at the site at any one time, the dates the material was present, the amount of each material that was used during the project, and how the material was used. The Contractor shall also ensure that hazardous materials are utilized in a manner that will minimize the amount of hazardous waste that is generated. The Contractor shall ensure that all containers of hazardous materials have NFPA labels or their equivalent. Copies of the MSDS for hazardous materials shall be kept on site at all times and provided to the COR at the end of the project. The Contractor shall certify that all hazardous materials removed from the site are hazardous materials and do not meet the definition of hazardous waste per 40 CFR 261.
- D. Petroleum Products: Conduct the fueling and lubricating of equipment and motor vehicles in a manner that protects against spills and evaporation. All used oil generated on the site shall be managed in accordance with 40 CFR 279. The Contractor shall determine if any used oil generated while on-site exhibits a characteristic of hazardous waste. In addition, used oil containing 1000 parts per million of solvents will be considered a hazardous waste and disposed of at Contractor's expense. Used oil mixed with a hazardous waste will also be considered a hazardous waste. All hazardous waste will be managed in accordance with the paragraph entitled Hazardous Waste/Debris Management of this section and shall be managed in accordance with the approved Environmental Protection Plan.

- E. Spills of Oil and Hazardous Materials: Take precautions to prevent spills of oil and hazardous material. In the event of a spill, immediately notify the COR. Spill response shall be in accordance with 40 CFR 300 and applicable State Regulations.

3.4 DUST CONTROL

- A. Keep dust down at all times, including during nonworking periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations. Dry power brooming will not be permitted. Instead, use vacuuming, wet mopping, wet sweeping, or wet power brooming. Air blowing will be permitted only for cleaning nonparticulate debris such as steel reinforcing bars. Only wet cutting will be permitted for cutting concrete blocks, concrete, and bituminous concrete. Do not unnecessarily shake bags of cement, concrete mortar, or plaster.

END OF SECTION 07 57 19

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SECTION 01 58 00 - CONSTRUCTION IDENTIFICATION SIGNS

PART 1 - GENERAL

1.1 REQUIREMENT INCLUDED

- A. Furnish, erect, and remove a construction identification sign(s) in accordance with the contract drawings and as directed by the COR.

PART 2 - PRODUCTS

- A. Sign Face: In accordance with the contract drawings. All edge sealed.
- B. Supports: In accordance with the contract drawings.
- C. Paint: Background and lettering - Exterior grade, latex, gloss paint. Colors as indicated on drawings.

PART 3 - EXECUTION

- A. Install where shown, minimum post embedment in accordance with the contract drawings.
- B. At final completion, remove sign and foundation. Restore site to original or proposed condition.

END OF SECTION 01 58 00

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SECTION 01 58 13 - POSTING OF NOTICES

PART 1 - GENERAL

1.1 SCHEDULE OF WAGE RATES AND BENEFITS

- A. The Contractor and each subcontractor under him shall post in a conspicuous place on the site (1) the schedule of the specified overall hourly rate for each applicable classification; (2) the amount of liquidated damages for any failure to pay such rates; and (3) the name and address of the responsible official in County or the U.S. Department of Labor (whichever is applicable) to whom complaints should be given.
- B. Copy of this Notice will be provided to the Contractor by the FAA.

1.2 NON-DISCRIMINATION CLAUSE

- A. In accordance with AMS Clause No. 3.6.2-9 Equal Opportunity, the Contractor shall post the non-discrimination clause as required by Executive Order 11246.
- B. The following is a statement of the required clause: Equal Employment Opportunity is the Law -- Discrimination is prohibited by the Civil Rights Act of 1964 and by Executive Order No. 11246. Title VII of the Civil Rights Act of 1964 -- Administered by: The Equal Employment Opportunity Commission. Prohibits discrimination because of Race, Color, Religion, Sex, or National Origin by Employers with 25 or more employees, by Labor Organizations with a hiring hall of 25 or more members, by Employment Agencies, and by Joint Labor-Management Committees for Apprenticeship or Training. Any person who believes he or she has been discriminated against should contact: The Equal Employment Opportunity Commission, 2401 E Street, NW, Washington, DC 20506.
- C. EXECUTIVE ORDER NO. 11246--Administered by: The Office of Federal Contract Compliance Programs prohibits discrimination because of Race, Color, Religion, Sex, or National Origin, and requires affirmative action to ensure equality of opportunity in all aspects of employment by all Federal Government Contractors and Subcontractors, and by Contractors Performing Work Under a Federal Assisted Construction Contract, regardless of the number of employees in either case. Any person who believes he or she has been discriminated against should contact: The Office of Federal Contract Compliance Programs, U.S. Department of Labor, Washington, DC 20210.

PART 2 – PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 58 13

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SECTION 01 71 33 - PROTECTION OF WORK AND PROPERTY

PART 1 - GENERAL

1.1 REQUIREMENT INCLUDED

- A. Protection of products after installation.
- B. Protection of existing property and landscape.

1.2 SUBMITTALS (Not Applicable)

PART 2 - PRODUCT

NOT USED

PART 3 - EXECUTION

3.1 PROTECTION AFTER INSTALLATION

- A. Protect installed products and control traffic in immediate area to prevent damage from subsequent operations.
- B. Provide protective coverings at walls, projections, corners and jambs, sills and soffits of openings in and adjacent to traffic areas.
- C. Cover walls and floors of elevator cabs and jambs of cab doors with 3/4-inch plywood, when elevators are used by construction personnel.
- D. Protect finished floors and stairs from dirt, wear, and damage:
 - 1. Secure heavy sheet goods or similar protective materials in place, in areas subject to foot traffic.
 - 2. Lay planking or similar rigid materials in place, in areas subject to movement of heavy objects.
 - 3. Lay planking or similar rigid materials in place, in areas where storage of products will occur.
- E. Protect waterproofed and roofed surfaces:
 - 1. Restrict use of surfaces from traffic of any kind and from storage of products.
 - 2. When an activity is mandatory, obtain recommendations for protection of surfaces from

manufacturer. Install protection and remove on completion of activity. Restrict use of adjacent unprotected areas.

- F. Restrict traffic of any kind across planted lawn and landscape areas.

3.2 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE

- A. The Contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property markers until the COR has witnessed or otherwise referenced their location and shall not move them until directed.
- B. The Contractor shall be responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in its manner or method of executing the work, or at any time due to defective work or materials, and said responsibility will not be released until the work is completed and accepted.
- C. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the nonexecution thereof by the Contractor, the Contractor shall restore, at its own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, or otherwise restoring as may be directed, or it shall make good such damage or injury in an acceptable manner, at no additional cost to the government.

END OF SECTION 01 71 33

SECTION 01 74 13 - CONSTRUCTION CLEANING

PART 1 - GENERAL

1.1 REQUIREMENT INCLUDED

- A. Cleaning and disposal of waste materials, debris, and rubbish during construction.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Provide covered containers for deposit of waste materials, debris, and rubbish.

PART 3 - EXECUTION

3.1 CLEANING

- A. Maintain areas under Contractor's control free of waste materials, scraps, surplus material, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums attics, crawl spaces and other closed or remote spaces, prior to closing the space.
- C. Clean interior areas daily to provide suitable conditions for work and to prevent fire or accidents.
- D. Use power brooms to clean paved areas as needed and immediately prior to opening any paved area to aircraft or vehicular traffic.
- E. All combustible waste materials shall be removed from buildings at the end of each working day.
- F. Broom clean interior areas prior to start of surface finishing and continue cleaning on a daily basis.
- G. Control cleaning operations so that dust and other particulates will not adhere to wet or newly coated surfaces.
- H. Responsibility for construction cleaning shall not be delegated to subcontractors performing construction work under this Contract.

3.2 DISPOSAL

- A. Remove waste materials, debris, and rubbish from site bi-weekly and legally dispose of off-site in an authorized disposal area.

3.3 CONTRACTOR'S FAILURE TO CLEAN

- A. If the Contractor fails to maintain levels of cleanliness in work areas, satisfactory to the COR, then the FAA shall have the right to cause such areas to be cleaned by others. The costs to the FAA for such cleaning, plus 25% for administration, shall be the obligation of the Contractor and shall be deducted from any money due the Contractor hereunder.

END OF SECTION 01 74 13

SECTION 01 77 00 - CLOSEOUT PROCEDURES FOR SUSTAINABLE DESIGN

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Compliance with Specification 01 77 10-Final Cleaning
 2. Compliance with Specification 01 78 23-Operation and Maintenance Data
 3. Compliance with Specification 01 78 36-Warranties and Guarantees
 4. Compliance with Specification 01 78 39-Project Record Documents
 5. Completion of Asbestos and Lead-Free Certification as per Division 1
 6. Completion of Lock Out/Tag Out (LOTO) Procedures as per Division 26
 7. Final Punch List

1.2 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 FAA of pending insurance changeover requirements.
 3. Obtain and submit releases permitting FAA unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 4. Prepare and submit Coordination Drawings, Project Record Documents, Facility Data COBie spreadsheets, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
 5. Deliver tools, spare parts, extra materials, and similar items to location designated by FAA. Label with manufacturer's name and model number where applicable.
 6. Make final changeover of permanent locks and deliver keys to FAA. Advise FAA's personnel of changeover in security provisions.
 7. Complete startup testing of systems.
 8. Provide a final TAB report and preliminary commissioning report. The preliminary commissioning report shall include all documents required from the beginning of the contract through the verification of all control sequences and mechanical equipment operations. There shall be no items that are reported in less than complete working order per the contract documents.
 9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

10. Advise FAA of changeover in utilities.
 11. Submit changeover information related to FAA's occupancy, use, operation, and maintenance.
 12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion, also referred to as the Contractor Acceptance Inspection (CAI). On receipt of request, COR will either schedule the inspection within 14 days or notify Contractor of unfulfilled requirements. COR will prepare the Certificate of Substantial Completion after the inspection or will notify Contractor of items, either on Contractor's list or additional items identified by COR, that must be completed or corrected before certificate will be issued. COR will also provide a punch list that will form the basis of requirements for the Final Completion.

1.3 FINAL COMPLETION

- A. Preliminary Procedures: Contractor should request final inspection prior to contract completion date. Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit a Final Application for Payment.
 2. Submit certified copy of COR's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by COR. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit a letter from the airport certifying that work areas located on the airport were left in a satisfactory condition.
 5. Perform a final cleaning in accordance with Section 01 77 10 "FINAL CLEANING".
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, COR will either proceed with inspection or notify Contractor of unfulfilled requirements. COR 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.

1.4 WARRANTIES

- A. Submit warranties in accordance with Section 01 78 36 "WARRANTIES AND GUARANTEES". Warranty period shall begin on date of Substantial Completion as listed in Certificate of Substantial Completion.
- B. Partial Occupancy: Submit properly executed warranties within fifteen (15) days of completion of designated portions of the Work that are completed and occupied or used by FAA during construction period by separate agreement with Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 – PRODUCTS:

NOT USED

PART 3 – EXECUTION:

NOT USED

END OF SECTION 01 77 00

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SECTION 01 77 10 - FINAL CLEANING

PART 1 - GENERAL

1.1 REQUIREMENT INCLUDED

- A. Final cleaning of project.

1.2 SUMMARY

- A. This section includes administrative and procedural requirements, protections of construction in progress, and for final cleaning at Substantial Completion.
- B. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and antipollution regulations.
- C. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.
- D. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final-cleaning operations. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- B. Cleaning Operations: Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or a portion of the Project.
 - 1. Clean the Project Site, yard and grounds, in areas disturbed by construction activities,

- including landscape development areas, of rubbish, waste material, litter, and foreign substances.
 - 2. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - 3. Broom and mop clean concrete floors in unoccupied spaces.
 - 4. Remove petrochemical spills, stains, and other foreign deposits.
 - 5. Remove tools, construction equipment, machinery, and surplus material from the site.
 - 6. Vacuum clean carpet and similar soft surfaces, removing debris and excess nap. Shampoo carpet as directed by COR.
 - 7. 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.
 - 8. Remove marks, stains, fingerprints, and other soils or other dirt from painted, decorated, and natural finished woodwork and other work.
 - 9. Remove spots, plaster, soil and paint from ceramic tile, marble, and other finished materials, and wash or wipe clean.
 - 10. Clean flooring materials thoroughly, including stripping, buffing, and waxing. Comply with materials manufacturer's instructions and recommendations.
 - 11. Remove labels that are not permanent labels.
 - 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. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - 14. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - 15. Clean ductwork, blowers, and coils of units that were operated during construction.
 - 16. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - 17. Leave the Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid the Project of rodents, insects and other pests. Comply with regulations of local authorities.
- D. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.
- E. Compliances: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.
- 1. Where extra materials of value remain after completion of associated work, they become the FAA's property. Dispose of these materials as directed by the FAA.
 - 2. The Contractor shall not dispose of debris or waste materials on the FAA's property without the prior written approval of the FAA.

END OF SECTION 01 77 10

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Maintenance manuals for the care and maintenance of products, materials, and finishes; systems and equipment.
 - 5. Manual for sustainable operations.

1.2 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 SUBMITTALS

- A. Comply with Section 01 40 10 for submission of Facility Data.
- B. Initial Submittal: Submit 2 bound draft copies of each manual and 2 electronic copies in PDF format at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. COR will return one copy of draft and mark whether general scope and content of manual are acceptable.
- C. Final Submittal: Submit two bound copies of each manual and two electronic copies (.pdf format) in final form at least 15 days before final inspection. If modifications are required, COR will return one copy with comments within 15 days after final inspection.
 - 1. Correct or modify each manual to comply with COR's comments. Submit 2 bound copies and 2 electronic copies of each corrected manual within 15 days of receipt of COR's comments.

1.4 COORDINATION

- A. Where operation and maintenance documentation include information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Organization: Include a section in the directory for each of the following:
 - 1. List of documents.
 - 2. List of systems.
 - 3. List of equipment.
 - 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Address of FAA.
 - 4. Date of submittal.
 - 5. Name, address, and telephone number of Contractor.
 - 6. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
 1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

Fire.

2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of FAA's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.4 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

- C. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.5 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 1. Standard printed maintenance instructions and bulletins.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training videotape, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.7 MANUAL FOR SUSTAINABLE OPERATIONS

- A. Provide all information required to operate building and its systems and components in an environmentally sustainable manner.
 - 1. Arrange manual to be used for training building staff.
 - 2. Include section on Integrated Pest Management (IPM).

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by FAA's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by FAA's operating personnel.
- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
1. Do not use original Project Record Documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared Record Drawings.
- G. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
1. Do not use original Project Record Documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared Record Drawings.
- G. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation. Comply with Section 01 40 10 for Facility Data requirements.

END OF SECTION 01 78 23

SECTION 01 78 36 - WARRANTIES AND GUARANTEES

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Preparation and submittal of warranties and guarantees.

1.2 FORM OF WARRANTY

- A. Bind in commercial quality 8 ½ x 11 inch three-ring side binders, with hardback, cleanable, plastic covers.
- B. Label cover of each binder with typed or printed title 'WARRANTIES AND GUARANTEES', with Contract No. and Project Title; name, address, and telephone number of Contractor.
- C. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified and the name of the product or work item.
- D. Separate each warranty or guaranty with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheet as necessary. List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

1.3 PREPARATION OF WARRANTY

- A. Obtain warranties and guarantees, executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten (10) days after completion of the applicable item of work. Date of beginning of time of warranty will be the date of Substantial Completion.
- B. Warranties and guarantees shall be made out in the name of and accrue to the benefit of the Federal Aviation Administration.

1.4 TIME OF WARRANTY

- A. Provide warranties prior to final acceptance.
- B. For items of work when acceptance is delayed beyond date of Substantial Completion, submit within ten (10) days after acceptance, listing the date of acceptance as the beginning of the warranty or guaranty period.

1.5 EQUIPMENT WARRANTY TAGS AND GUARANTEE LOCAL REPRESENTATIVES

- A. The Contractor shall furnish with each guarantee, the name address, and telephone number of the guarantor, the name, address, and telephone number of the guarantor's representative nearest to the site, who, upon request of the FAA representative, will honor the guarantee during the guaranty period and will provide the service prescribed by the terms of the guarantee. At the time of installation, the Contractor shall tag each item of warranted equipment with a durable, oil and water-resistant tag approved by the COR. Tag shall be attached with copper wire and sprayed with a clear silicone, waterproof coating. Leave the date of acceptance and inspectors signature blank until project is accepted for Substantial Completion. Tag shall show the following information:
- B. Equipment warranty tags
 - 1. Type of Equipment
 - 2. Accepted Date
 - 3. Warranted Until
 - 4. Under Contract Number
 - 5. Inspector's Signature

1.6 QUANTITY

- A. Provide three (3) complete copies of warranties and guarantees.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 78 36

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. This section describes the requirements for the creation and maintenance of “As Built Drawings;” referred to herein as Record Documents.
- B. The Construction Contract Drawings utilize Computer Aided Design (CAD) methodology. The Contractor shall use the Government furnished CAD files to electronically reconfigure, modify, and update the Construction Contract Drawings with as-built information so as to develop Record Documents. Government furnished CAD files shall be updated by the Contractor to include as built layout and facility data shown on Shop Drawings, product submittals, and material submittals approved in accordance with Section 01 33 00.
- C. Maintenance of Record Documents.
- D. Submittal of Record Documents.

1.2 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Store Record Documents in Field Office apart from documents used for construction. Provide files, racks, and secure storage for Record Documents.
- B. Maintain Record Documents in clean, dry, and legible conditions. Do not use Record Documents for construction purposes.
- C. Keep Record Documents and Samples available for inspection by FAA.

1.3 AS-BUILT INFORMATION

- A. Record information on a set of full-size drawings, provided by FAA.
- B. Provide felt tip marking pens, maintaining separate colors for each major system, for recording information.
- C. Record information concurrently with construction progress. Do not conceal any work until required information is recorded. Electronically update all CAD files to generate Record Documents with recorded information.
- D. Contract Drawings and approved Shop Drawings: Legibly mark each item to record actual construction, including:
 - 1. Measured depths of elements of foundation in relation to finish grade or first 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 construction.
 4. Field changes of dimensions and details.
 5. Changes made by Addenda, Change Order(s) (if any) and Work Order(s) (if any).
 6. Details not on original Contract Drawings.
 7. References to related Shop Drawings and Modifications.
- E. Specifications: Legibly mark each item to record actual construction, including changes made by Addenda and Change Order.
- F. Other Documents: Maintain manufacturer's certification, inspection certifications, field test records, and training documents required by individual Specification Sections.

1.4 SUBMITTALS

- A. At Substantial Completion, deliver Record Documents and samples under provision of Section 01 77 00, "CLOSEOUT PROCEDURES".
- B. Provide Portable Document Format (PDF) file of all record drawings on 700+ MB compact disk or other approved electronic media and upload PDF to FAA's KSN website.
- C. Provide CAD-produced Record Documents of all underground utilities including location, elevation, and size of all pipes, conduits, manholes, drainage structures, duct banks, etc. from as-built information.
- D. Provide CAD produced Record Drawing(s) of all Construction Contract Drawings from as-built information incorporated into the CAD files.
- E. Provide .dwg and .pdf files of same.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 78 39

SECTION 01 81 09 - TESTING FOR INDOOR AIR QUALITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, other Division 1 Specification Sections, and specifications of materials mentioned in this section, apply to this Section.

1.2 SUMMARY

- A. General: This section provides requirements for Baseline Indoor Air Quality (IAQ) Testing for maximum indoor pollutant concentrations for acceptance of the facility.

1.3 SUBMITTALS

- A. Baseline IAQ Testing: Submit a report for each test site specified for IAQ baseline testing as prescribed herein below and in Division 23, in the section on "Testing, Adjusting, and Balancing." Report on air concentrations of targeted pollutants identified in Subsection 3.1 of this section.

1.4 SEQUENCING AND SCHEDULING

- A. Identify, program, and schedule all IAQ testing well in advance of construction in a manner to prevent delays to the performance of the work of this Contract in order to perform and complete all testing after the completion of construction activities and prior to occupancy.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

BASELINE IAQ TESTING

- A. HVAC System Verification: To assure compliance with recognized standards for indoor air quality including ASHRAE Standard 62.1-2007, the Contractor's independent testing and balancing agency shall verify the performance of each HVAC system prior to Indoor Air Quality testing, including space temperature and space humidity uniformity, outside air quantity, filter installation, drain pan operation, and any obvious contamination sources.

- B. Indoor Air Quality Testing: Upon verification of HVAC system operation, the Contractor shall hire an independent contractor, subject to approval by the Contracting Officer's Representative, with a minimum of 5 years' experience in performing the types of testing specified herein, to test levels of indoor air contaminants for compliance with specified requirements.
1. Conduct baseline IAQ testing using testing protocols consistent with the United States Environmental Protection Agency Compendium of Methods for the Determination of Air Pollutants in Indoor Air.
 2. A test plan shall be submitted for the approval of the Contracting Officer's Representative. The plan shall specify procedures, times, instrumentation, and sampling methods that will be employed.
 3. Perform IAQ testing for at least the minimum number of required sampling locations, determined as follows: For each portion of the building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft., or for each contiguous floor area, whichever is larger, and include areas with the least ventilation as calculated by Ventilation Rate Procedure of ASHRAE Standard 62.1-2004 and greatest presumed source strength as identified by Owner. Collect air samples on three consecutive days and average the results of each three-day test cycle to determine compliance or non-compliance of indoor air quality for each air handling zone tested.
 - a. Verify areas to be tested with the Contracting Officer's Representative. Areas with 100 percent outside air ventilation rates such as laboratories are excluded from these testing requirements. The Contracting Officer's Representative is the sole judge of areas exempt from testing.
 4. Perform IAQ testing following the completion of all interior construction activities and prior to occupancy. The building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Perform testing prior to installation of furniture, workstation components, and casework.
 5. Perform IAQ testing within the breathing zone, between 3'-0" and 6'-0" above the finished floor and over a minimum 4-hour period.
 6. Collect air samples during normal occupied hours (prior to occupancy) with the building ventilation system starting at the daily normal start times and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
 7. Sample and record outside air levels of formaldehyde and TVOC contaminants at three outside air locations (as determined by Owner) simultaneously with indoor tests to establish basis of comparison for these contaminant levels by averaging the three outdoor readings for each contaminant.
 8. Perform airborne mold and mildew air sampling and speciation with simultaneous indoor and outdoor readings.
 - a. Samples are to be collected using a 12 liter-per-minute pump and a 0.45-micron polycarbonate filter, with a 4-hour duration for each sample.
 - b. Speciation shall be done with DNA detection using the quantitative polymerase chain reaction (QPCR) method. To ensure that filters are not pre-contaminated with mold, a field blank filter cartridge shall be tested after every eighth sample is tested.
 9. Acceptance of respective portions of the building by the Owner is subject to compliance with specified limits of indoor air quality contaminant levels.

- C. Indoor air quality shall conform to the following standards and limits:
1. Formaldehyde: <20 microgram/m³ (16.3 ppb)
 2. Sum of VOCs: <200 microgram/m³
 3. Carbon Monoxide: Not to exceed 9 ppm
 4. Other compounds found on the California Office of Environmental Health Hazard Assessment's list of chronic inhalation Reference Exposure Levels (RELs) are not to exceed those levels, as published on:
http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html
 5. Airborne Mold and Mildew: The species identified in indoor air cannot vary by more than 10 percent from those identified in the exterior samples.
- D. Test Reports: Prepare test reports showing the results and location of each test, a summary of the HVAC operating conditions, and a listing of any discrepancies and recommendations for corrective actions, if required.
1. Include certification of test equipment calibration with each test report.
- E. For each sampling point where the maximum concentration limits are exceeded, the Contractor is responsible for conducting additional flush-out with outside air and retesting the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting non-complying building areas, take samples from the same locations as in the first test. Retesting shall be performed at no additional expense to the Owner.
- F. For each sampling point where the airborne mold and mildew indoor species distribution varies by more than 10 percent from exterior sampling speciation, Contractor shall identify the source of the mold and/or mildew and remediate with corrective action, then retest in accordance with section 3.1.B above until compliant results are attained.
- G. In the event that any non-compliant test results occur, Contractor must provide a written report to the Owner describing the source(s) of the non-compliant condition(s) and the corrective action(s) implemented.

INDEPENDENT MATERIALS TESTING:

- A. Materials That Must Be Tested: All materials listed below that are proposed for use on this project shall be tested for permanent, in-place indoor air quality performance in accordance with requirements of these specifications. Results shall be furnished to the Contracting Officer's Representative. Materials meeting the criteria for independent testing are as follows:
1. Field-applied paint systems on appropriate substrate. Paint primers and intermediate coats (if used) should be applied with a typical drying time allowed between coats (not to exceed 7 days).
 2. Wall coverings
 3. Carpet including manufacturer's recommended adhesive. The carpet will be applied to the appropriate flooring per manufacturer's instructions so that the testing is of the "carpet assembly."
 4. Ceiling tile

5. Interior furnishings
 6. Any fireproofing material that may be exposed to indoor air, directly or in a plenum, applied to appropriate substrate
- B. Materials for Testing: Only test representative samples of actual products selected for use on this project. Tests of products generically and/or technically similar but produced by a manufacturer other than that of the product selected for use on this project are invalid.
- C. Materials Testing and Evaluation Protocol: California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," July 2004. available online:
<http://www.dhs.ca.gov/ps/deodc/ehlb/iaq/VOCS/>
- D. Performance Thresholds: All compounds detected that have chronic reference exposure levels listed in the California DHS Standard Practice document shall be analyzed and compared to the allowable concentration levels.
- E. Materials Test Reports: Submit test reports to the Contracting Officer's Representative. The report shall include raw emission levels, as well as the calculated resulting concentrations and the assumptions (loading, volume of space, ventilation rates) used to determine those resulting concentrations.
- F. Product/Material Evaluation: All products/materials shown by testing to comply with emissions limits and other criteria specified in this section will be approved for use on this project subject to compliance with all other specified requirements of the Project Manual. Products/materials shown to exceed specified emission limits shall be discussed, test results interpreted, and a determination made as to alternative product uses or selections.

END OF SECTION 01 81 09

SECTION 02 01 00 – INTERIM LIFE SAFETY MEASURES FOR FACILITIES UNDER CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. During construction activities, it is likely temporary hazards may be posed due to the work being conducted in the facility. Interim Life Safety Measures (ILSM) are actions that must be taken to compensate for the temporary hazards. This document addressed administrative actions which must be taken to ensure the current level of life safety is maintained at all times and occupants are not subjected to hazardous conditions for even short periods of time.
- B. Implementation and Enforcement: Implementation and enforcement of ILSM is the responsibility of all occupants within the building, including employees and construction personnel. However, primary identification of hazards and the actions taken to compensate for temporary hazards are the responsibility of the Contractor. All ILSM are subject to approval by the Contracting Officer Representative.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION MEETING

- A. Prior to commencement of construction, conduct a meeting to inform all Tower and Base Building occupants (employees and construction personnel) of the project scope and duration. This should include, at a minimum, the following:
 - 1. An overview of the construction project.
 - 2. A preliminary schedule for the construction.
 - 3. Discussion of affected fire protection and life safety systems including active and passive features.
 - 4. Discussions of the effect on daily and emergency operations.
 - 5. Handout of written policies for ILSM for all employees and construction personnel.
 - 6. Demonstration of signs, messages, etc., to be used to identify hazardous conditions and the corresponding ILSM.
 - 7. List of contacts for reporting hazardous conditions.
 - 8. Discussion of anticipated hazards throughout the project and the ILSM for each.

3.2 ACTIVE AND PASSIVE FIRE PROTECTION AND LIFE SAFETY FEATURES

- A. Due to the criticality of FAA facilities, most facilities are provided with a number of active and

passive fire protection and life safety features. If any of these features are compromised in any way, ILSM shall be instituted immediately. These features include:

1. Fire-resistive construction.
2. Stair ventilation system (stair pressurization or vented vestibule).
3. Fire detection and alarm system.
4. Exit signage.
5. HVAC shutdown.
6. Unlocking security doors.

3.3 SITUATIONS COMPROMISING LIFE SAFETY

A. General concepts of situations which compromise the level of life safety as required by the applicable codes and standards include:

1. Blocked or obstructed exits.
2. Obstructed access for emergency vehicles and personnel.
3. Fire protection system malfunctioning or out of service.
4. Storage of additional combustibles or flammable liquids.
5. Temporary sources of ignition due to construction activities (cutting, welding, etc.).
6. Temporary penetrations in fire-rated walls and partitions (including missing doors).

B. Single Means of Egress: All work shall be conducted in such a way as to not obstruct or compromise the single means of egress from the ATCT.

3.4 SMOKING

A. Smoking shall not be permitted at any time in FAA facilities.

3.5 NOTIFICATION SIGNAGE

A. The Contractor shall provide appropriate signage, in locations approved by the Contracting Officer Representative, to notify occupants of current activities and ILSM in effect at the facility. The signage shall be verified prior to each construction shift and employee shift. The signage shall indicate the present hazards and the safety measure provided to compensate for the hazards.

3.6 QUALITY CONTROL

A. During construction, the following practices shall be adhered to in addition to those required for specific hazards discussed below:

1. Construction personnel shall check all doors opening into stairs to ensure door hardware is functioning properly. This includes a visual inspection of all doors to ensure the construction has not been compromised and checking all door hardware including latching hardware and self-closing devices to verify proper operation. Any deficient components shall be repaired or replaced immediately.
2. The temporary use of wood chocks or other objects to prop open fire-rated doors shall be permitted as necessary for construction work. At the completion of work for the day, the

- construction supervisor shall verify all propped doors have been returned to the closed position.
3. The construction supervisor shall inspect the job site a minimum of twice per week to verify all life safety features are present and operational and have not been damaged by construction, including:
 - a. Exit signage.
 - b. Exits are free of storage or obstructions.
 - c. Exit stairs, including treads, landings, handrails, headroom.
 - d. Exit illumination.
 - e. Emergency lighting (battery-operated).
 - f. Evacuation route maps (ensure these are installed and readily visible).
 4. If the fire alarm system is not provided with offsite monitoring, provide a telephone with a direct line to the fire department for notification in case of a fire. The Contracting Officer Representative shall approve the location of the telephone.
 5. Inform the fire department of construction activities in the facility and provide them a copy of written ILSM policies. The Contractor shall regularly update the fire department on the status of construction and ILSM (minimum of once every two weeks).

3.7 OPERATIONAL FIRE ALARM SYSTEM

- A. If the facility fire alarm system is not operational, is malfunctioning, or is in a trouble condition due to construction activities, the Contractor shall provide, at a minimum, the following additional ILSM.
- B. Inform Fire Department: Inform the fire department of the problems with the facility fire alarm system and inform them of the ILSM being taken to compensate for the deficient system.
- C. Trouble Signals: Ensure trouble signals at the main fire alarm control panel and the Cab and TRACON annunciator panels remain functional until the system is returned to proper function. Trouble signals at either panel shall not be bypassed.
- D. Magnetic Door Hold-Open Devices: Test magnetic door holders to ensure these devices still operate via the fire alarm system. If door holders do not work, all door holders shall be disabled and shall not be returned to use until the fire alarm system is returned to normal.
- E. Facility Inspections: Construction supervisors shall inspect all areas prior to each shift to ensure all active and passive fire protection features are still operational including all fire doors are in closed position and are not propped open, and the sprinkler system is still functional (i.e. valves are in the open position), if applicable.
- F. Fire Alarm Inoperable at End of Shift: If the fire alarm system is not operational at the end of the construction shift, provide a temporary, manual switch in the Cab to activate the stair ventilation system (ATCT's only).

3.8 TEMPORARY IGNITION SOURCES

- A. When construction activities involve the use of temporary ignition sources ("hot works"), i.e., welding, cutting, plumbers torch, etc., the Contractor shall provide, at a minimum, the following ILSM. (Note: Additional measures may be required by the Contracting Officer Representative for specific situations.)
1. Inform construction supervisor of hazardous operations.
 2. Keep a log of all hot work activities.
 3. Provide the appropriate type of fire extinguisher to the personnel performing the work (all construction personnel shall be trained in the proper use of fire extinguishers prior to the commencement of work).
 4. Disable any fire alarm initiating devices or zones that may be susceptible to a false alarm during the operation. Notify the Contracting Officer Representative prior to disabling fire alarm devices.
 5. Return all fire alarm devices to normal operation at the completion of work. At the end of the shift, all fire alarm devices shall be returned to operational condition regardless of the status of the work.

3.9 STORAGE OF COMBUSTIBLES

- A. When construction activities involve the storage of an unusual amount of combustibles and/or combustible liquids within the facility, the Contractor shall provide, at a minimum, the following ILSM. (NOTE: The Specification addressed Contractor storage spaces and other limitations. Additional measures may be required by the Contracting Officer Representative for specific situations.)
1. Submit a written request to the Contracting Officer Representative requesting permission to store materials within the facility. The request shall indicate the proposed location, types and quantities of combustibles, MSDS sheets (if applicable), approximate duration of storage and proposed ILSM. The Contracting Officer Representative will provide a copy of all requests to the FAA Safety and Environmental Compliance Manager.
 2. Provide additional fire extinguishers appropriate for the anticipated hazard.
 3. Ensure proper cleaning techniques are utilized in the storage area at the end of each shift. This includes cleaning all dust and waste materials, replacing lids on liquids, cleaning all spills, returning all flammable and combustible liquids to a flammable liquid's storage locker.
 4. Check throughout the storage area daily for exposed ignition sources. Any exposed ignition sources shall be repaired or removed from the storage area.

3.10 STAIR VENTILATION SYSTEM

- A. Conduct a meeting to inform all air traffic personnel upon restoring the stair ventilation system to normal operation.

END OF SECTION 02 01 00

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SECTION 02 03 00 – GENERAL REQUIREMENTS FOR DEMOLITION AND RENOVATION

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
- B. AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
 - 1. AHRI Guideline K (2005) Guideline for Containers for Recovered Non-Flammable Fluorocarbon Refrigerants
- C. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
 - 1. AASHTO M 145 (1991; R 2004) Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
 - 2. AASHTO T 180 (2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in) Drop
- D. AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)
 - 1. ASSE/SAFE A10.6 (2006) Safety Requirements for Demolition Operations
- E. CARPET AND RUG INSTITUTE (CRI)
 - 1. CRI (2009) CRI Carpet Installation Standard
- F. U.S. ARMY CORPS OF ENGINEERS (USACE)
 - 1. EM 385-1-1 (2008) Safety and Health Requirements Manual
- G. U.S. DEPARTMENT OF DEFENSE (DOD)
 - 1. DOD 4000.25-1-M (2006; Notice 1) Requisitioning and Issue Procedures
- H. U.S. FEDERAL AVIATION ADMINISTRATION (FAA)
 - 1. FAA AC 70/7460-1 (Rev K) Obstruction Marking and Lighting
- I. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
 - 1. 40 CFR 61 National Emission Standards for Hazardous Air Pollutants
 - 2. 40 CFR 82 Protection of Stratospheric Ozone

3. 49 CFR 173.301 Shipment of Compressed Gases in Cylinders and Spherical Pressure Vessels

1.2 GENERAL REQUIREMENTS

- A. This Section specifies administrative and procedural requirements for demolition and renovation. Refer to other Sections for specific work requirements and limitations applicable to individual parts of the work. Requirements of this Section apply to all disciplines. Refer to specific Sections for other requirements and limitations applicable to the work.
- B. Do not begin demolition until authorization is received from the COR. Do not allow accumulations inside or outside the building. The work includes demolition and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the COR. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.
- C. Protection of Existing Property: Before beginning any demolition work, the Contractor shall carefully survey the site and examine the drawings and specification to determine the extent of the work. The Contractor shall take all necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain in property of the Government, and any damaged items shall be repaired or replaced as approved by the COR at no additional cost to the Government. The Contractor shall carefully coordinate the work of this section with all other work and shall construct and maintain shoring, bracing and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.
- D. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio.
- E. Operational and Safety Limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance, or decreased operational life or safety.
- F. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in the COR's opinion, reduce the building's aesthetic qualities or result in visual evidence of cutting and patching. Remove and replace work cut and patched in a visually unsatisfactory manner.

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
 - 1. Demolition Plan

1.4 REGULATORY AND SAFETY REQUIREMENTS

- A. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6.
- B. Notifications:
 - 1. General Requirements: Furnish timely notification of demolition projects to the COR in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M.

1.5 DUST AND DEBRIS CONTROL

- A. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Vacuum and dust the work area daily.

1.6 PROTECTION

- A. Traffic Control Signs:
 - 1. Where pedestrian, driver or aircraft safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the COR prior to beginning such work.
 - 2. Contractor must provide a minimum of 2 aviation red or high intensity white obstruction lights on temporary structures (including cranes) over 100 feet (30 meters) above ground level. Light construction and installation must comply with FAA AC 70/7460-1. Lights must be operational during periods of reduced visibility, darkness, and as directed by the COR. Maintain the temporary services during the period of construction and remove only after permanent services have been installed and tested and are in operation.
- B. Items to Remain in Place: Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government. Repair or replace damaged items as approved by the COR. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition work. Repairs, reinforcement, or structural replacement require approval by the COR prior to performing such work.
- C. Existing Construction Limits and Protection: Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove snow, dust, dirt, and debris from work areas daily.
- D. Weather Protection: For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is

necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas.

- E. Trees: Protect trees within the project site which might be damaged during demolition, and which are indicated to be left in place. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the COR.
- F. Utility Service: Maintain existing utilities indicated to stay in service and protect against damage during demolition and operations. Coordinate with COR for shutdown utilities.
- G. Facilities: Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated on drawings, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the COR. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.
- H. Protection of Personnel: Before, during and after the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished or deconstructed and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.7 BURNING

- A. The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.8 RELOCATIONS

- A. Perform the removal and reinstallation of relocated items as indicated on drawings with workmen skilled in the trades involved. Items to be relocated which are damaged by the Contractor shall be repaired or replaced with new undamaged items as approved by the COR.

1.9 REQUIRED DATA

- A. Prepare a Demolition Plan. Include in the plan procedures for careful removal and disposition of materials to be reused, coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Include statements affirming Contractor inspection of the existing roof deck and its suitability to perform as a safe working platform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan shall be approved by COR prior to work beginning.

1.10 ENVIRONMENTAL PROTECTION

- A. Comply with the Environmental Protection Agency requirements specified.

1.11 USE OF EXPLOSIVES

- A. Use of explosives will not be permitted.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Use materials that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials .

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to Cutting Existing Surfaces: Examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered.
- B. Prior to Proceeding: Meet at the site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

3.2 PREPARATION

- A. Provide temporary support of work to be cut. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas. Take all precautions necessary to avoid cutting existing pipe, conduit or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 EXISTING FACILITIES TO BE REMOVED

A. GENERAL

- 1. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse.
- 2. Existing Structures:

- a. Remove existing structures indicated to be removed to top of foundation walls. Break up basement slabs to permit drainage. Remove sidewalks, curbs, gutters and street light bases as indicated on drawings.
 - b. Interior walls, other than retaining walls and partitions, shall be removed to top of concrete slab on ground.
 - c. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each level before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the COR.
 - d. Locate demolition equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors, or framing.
3. Cutting and Patching:
- a. Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
 - b. Cutting: Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition. Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible review proposed procedures with the original installer; comply with original installer's recommendations. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 1) Avoid Marring Existing Surfaces: To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
 - 2) Concrete and Masonry Surfaces: Cut through concrete and masonry using a cutting machine such as carborundum saw or diamond core drill.
 - 3) Utility Services: Bypass utility services such as pipe or conduit before cutting, where services are shown or required to be removed, relocated or abandoned. Remove pipe or conduit in walls or partitions that are noted to be removed, unless noted by Contracting Officer Representative to be cut-off. Cap, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after bypassing and cutting. Use approved firestopping methods in all fire-rated walls, floors or ceilings.
 - c. Patch: Patch with durable seams that are as invisible as possible. Comply with specified tolerances. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

- d. Finish Restoration: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - e. Finish Restoration in More than One Area: Where removal of walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - f. Smooth Painted Surfaces: Where patching occurs in a smooth painted surface, extend final paint coat over entire area containing the patch, after the patched area has received primer and second coat.
 - g. Existing Ceilings: Patch, repair or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.
4. Items with Unique/Regulated Disposal Requirements: Remove and dispose of items with unique or regulated disposal requirements in the manner dictated by law or in the most environmentally responsible manner.

B. CIVIL

1. Utilities and Related Equipment:
- a. General Requirements: Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the COR. Do not interrupt existing utilities serving facilities occupied and used by the Government or adjacent tenants except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated on drawings.
 - b. Disconnecting Existing Utilities: Remove existing utilities as indicated on drawings and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the COR. When utility lines are encountered that are not indicated on drawings on the drawings, the COR shall be notified prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the COR.
2. Paving and Slabs: Remove or sawcut concrete paving and slabs as indicated on drawings to a depth of 12 inches below existing adjacent grade.

C. ARCHITECTURAL

1. Roofing: Remove existing roof system and associated components in their entirety down to existing roof deck. Remove roofing system and insulation without damaging the roof deck. Sequence work to minimize building exposure between demolition and new roof materials installation.
- a. Temporary Roofing: Install temporary roofing and flashing as necessary to maintain a watertight condition throughout the course of the work. Remove temporary work prior to installation of permanent roof system materials unless

approved otherwise by the COR. If the existing deck or support structure is deteriorated where indicated, such that ability to support foot traffic and construction loads is unknown. Make provisions for worker safety during demolition, and installation of new materials.

- b. Reroofing: When removing the existing roofing system from the roof deck, remove only as much roofing as can be recovered by the end of the work day, unless approved otherwise by the COR. Do not attempt to open the roof covering system in threatening weather. Reseal all openings prior to suspension of work the same day.
2. Carpentry: Remove and reinstall windows, doors, frames, and cabinets, and similar items as whole units, complete with trim and accessories as indicated on drawings. Do not remove hardware attached to units, except for door closers unless noted otherwise in drawings. Brace the open end of door frames to prevent damage.
3. Carpet: Remove existing carpet in accordance with manufacturer recommendations. Remove adhesive according to recommendations of the Carpet and Rug Institute (CRI). Adhesive removal solvents shall comply with CRI 104.
4. Acoustic Ceiling Tile: Remove and store ceiling tiles to be reused if indicated on drawings.
5. Locksets on Swinging Doors: The Contractor shall remove all locksets from all swinging doors indicated on drawings to be removed and disposed. Deliver the locksets and related items to a designated location for receipt by the COR after removal.

D. STRUCTURAL

1. Masonry: Sawcut and remove masonry so as to prevent damage to surfaces to remain and to facilitate the installation of new work. Where new masonry adjoins existing, the new work shall abut or tie into the existing construction as specified for the new work. Provide square, straight edges and corners where existing masonry adjoins new work and other locations.
2. Concrete: Saw concrete along straight lines to a depth of a minimum 2 inch. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete.
3. Structural Steel: Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Flame-cutting torches are permitted when other methods of dismantling are not practical. Any structural steel to be reuse shall be stored off the ground and protected from the weather.
4. Miscellaneous Metal: When shop-fabricated items such as access doors and frames, steel gratings, metal ladders, metal railings, metal windows and similar items and light-gage and cold-formed metal framing, metal toilet partitions, toilet accessories and similar

items will be reused, removed them as whole units and shall be store and protected from weather.

E. MECHANICAL

1. Air Conditioning Equipment: Remove air conditioning, refrigeration, and other equipment containing refrigerants without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990. Recover all refrigerants prior to removing air conditioning, refrigeration, and other equipment containing refrigerants and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."
2. Cylinders and Canisters: Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."
3. Mechanical Equipment and Fixtures: Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Mechanical equipment and fixtures must be disconnected at fittings. Remove service valves attached to the unit. Do not remove equipment until approved.
4. Piping: Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths. If the piping that remains can become pressurized due to upstream valve failure, end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve shall be attached to the open end of the pipe to ensure positive leak control. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property.

F. ELECTRICAL

1. Electrical Equipment and Fixtures: Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.
 - a. Fixtures: Remove electrical fixtures as indicated on drawings.
 - b. Electrical Devices: Remove switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items as indicated on drawings.
 - c. Wiring Ducts or Troughs: Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway.
 - d. Conduit and Miscellaneous Items: Remove conduit except where embedded in concrete or masonry as indicated on drawings. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.4 DISPOSITION OF MATERIAL

- A. Title to Materials: All materials and equipment removed shall become the property of the Contractor and shall be removed from Government property.
- B. Reuse of Materials and Equipment: Remove and store materials and equipment indicated to be reused to prevent damage and reinstall as the work progresses.
- C. Disposal of Ozone Depleting Substance (ODS): Class I and Class II ODS are defined in Section, 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. Recovered ODS shall be removed from Government property and disposed of in accordance with 40 CFR 82. Products, equipment, and appliances containing ODS in a sealed, self-contained system (e.g., residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82.
 - 1. Special Instructions: No more than one type of ODS is permitted in each container. A warning/hazardous label shall be applied to the containers in accordance with Department of Transportation regulations. All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:
 - a. Activity name and unit identification code.
 - b. Activity point of contact and phone number.
 - c. Type of ODS and pounds of ODS contained.
 - d. Date of shipment.
 - 2. Fire Suppression Containers: Deactivate fire suppression system cylinders and canisters with electrical charges or initiators prior to shipment. Also, safety caps must be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.
- D. Transportation Guidance: Ship all ODS containers in accordance with MIL-STD-129, DLA 4145.25 (also referenced one of the following: Army Regulation 700-68, Naval Supply Instruction 4440.128C, Marine Corps Order 10330.2C, and Air Force Regulation 67-12), 49 CFR 173.301, and DOD 4000.25-1-M.

3.5 DISPOSAL OF REMOVED MATERIALS

- A. Regulation of Removed Materials: Dispose of debris, rubbish, scrap, and other materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified.
- B. Burning on Government Property: Burning of materials removed from demolished structures will not be permitted on Government property.
- C. Removal to Spoil Areas on Government Property: Transport noncombustible materials removed from demolition structures to designated spoil areas on Government property.
- D. Removal from Government Property: Transport waste materials removed from demolished structures, from Government property for legal disposal. Dispose of waste soil as directed.

END OF SECTION 02 03 00

SECTION 02 82 15 – THIRD PARTY AIR MONITORING FOR ASBESTOS CONTAINING MATERIALS

PART 1 – GENERAL

1.1. REFERENCE

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The current version of referenced publications at the time of the bid shall be used. Where conflicts exist between documents, the most stringent requirements shall apply.

- A. American National Standards Institute (ANSI)
 - 1. ANSI Z9.2 (1979; R 1991), Fundamentals Governing the Design and Operation of Local Exhaust Systems
 - 2. ANSI Z87.1 (1989; Errata; Z87.1a), Occupational and Educational Eye and Face Protection.
 - 3. ANSI Z88.2 (1992), Respiratory Protection.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM E 1368 (1997), Visual Inspection of Asbestos Abatement Projects
 - 2. ASTM D 2986-95A, Evaluation of Air Assay Media by the Monodisperse DOP (Diocetyl Phthalate) Smoke Test
- C. United States Occupational Safety and Health Administration (OSHA)
 - 1. 29 CFR 1910, Occupational Safety and Health Standards
 - 2. 29 CFR 1926, Safety and Health Regulations for Construction
- D. Compressed Gas Association (CGA)
 - 1. CGA G-7 (1990), Compressed Air for Human Respiration
 - 2. CGA G-7.1 (1997), Commodity Specification for Air
- E. Environmental Protection Agency (EPA)
 - 1. EPA 340/1-90-018 (1990), Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance
 - 2. EPA 340/1-90-019 (1990), Asbestos/NESHAP Adequately Wet Guidance
 - 3. EPA 560/5-85-024 (1985), Guidance for Controlling Asbestos-Containing Materials in Buildings
 - 4. EPA 600/4-85-049 (1985), Measuring Airborne Asbestos Following an Abatement Action
 - 5. 40 CFR 61, National Emission Standards for Hazardous Air Pollutants
 - 6. 40 CFR 763, Asbestos Hazard Emergency Response Act, Asbestos School Hazard Abatement Reauthorization Act
- F. National Institute For Occupational Safety and Health (NIOSH)
 - 1. NIOSH Pub No. 94-113 (1994), NIOSH Manual of Analytical Methods, *4th Edition with First Supplement*

- G. Underwriters Laboratories (UL)
 - 1. UL 586 (1990), High-Efficiency Particulate Air Filter Units
- H. ASHRAE
 - 1. SPC 52.2P, Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
- I. Federal Aviation Administration (FAA)
 - 1. FAA Order 3910.50, Asbestos Con
 - 2. FAA Order 1050.20, Airway Facilities Asbestos Control
 - 3. Regional Asbestos Control Program Supplement
 - 4. Article 77, Agreement Between DOT/FAA and the National Air Traffic Controller Association (NATCA)
 - 5. Article 52, Agreement Between DOT/FAA and the Professional Airways System Specialists (PASS)
 - 6. Local Asbestos O&M Plan
 - 7. Local Facility Asbestos Abatement Contingency Plan

1.2. DEFINITIONS

- A. Adequately Wet: A term as defined in 40 CFR 61, Subpart M and EPA 340/1-90-019 that means to sufficiently mix or penetrate with liquid to prevent the release of particulates. If visible emissions are observed coming from asbestos-containing material (ACM), then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wetted.
- B. Asbestos Containing Material: Any material containing more than one percent asbestos. For purposes of these specifications, ACM includes presumed asbestos-containing material (PACM) as defined by 29 CFR 1926.1101.
- C. Asbestos Regulated Work Area: An area established to demarcate areas where Class I, II, and III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work accumulates; and a work area where the airborne concentration of asbestos fibers exceeds, or has a possibility to exceed, the permissible exposure limit.
- D. Certified Industrial Hygienist (CIH): An Industrial Hygienist certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene.
- E. Class I Asbestos Work: Activities involving the removal of thermal system insulation (TSI) and surfacing ACM
- F. Class II Asbestos Work: Activities involving the removal of ACM that is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic. In some cases, certain “incidental” roofing materials such as mastic, flashing and cements when they are still intact are excluded from Class II asbestos work.
- G. Class III Asbestos Work: Repair and maintenance operations where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, or cutting a hole, cable pulling, and crawling through tunnels or attics and spaces above the ceiling where ACM or asbestos-containing debris may be disturbed. Removal of

small amounts of ACM that would fit into a single glove bag or disposal bag may be classified as a Class III job.

- H. Class IV Asbestos Work: Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction.
- I. Disturbance: Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM.
- J. Friable ACM: A term as defined in 40 CFR 61, Subpart M and EPA 340/1-90-018 that means any material containing more than 1 percent asbestos as determined using the method specified in 40 CFR 763, Appendix A, Subpart F, Section 1, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.
- K. High Efficiency Particulate Air (HEPA) Filter: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers or greater in diameter.
- L. Industrial Hygienist: A professional qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational health hazards.
- M. Permissible Exposure Limits: OSHA PELs are worker exposure limits regulating the amount or concentration of a substance in air that shall not be exceeded. (1) An airborne concentration of asbestos of 0.1 fibers per cubic centimeter of air (f/cc) as an eight- (8) hour time weighted average (TWA). (2) An airborne concentration of asbestos of 1.0 f/cc as averaged over a sampling period of thirty (30) minutes (Excursion Limit).
- N. Time-Weighted Average (TWA): The TWA is an 8-hour time weighted average of airborne concentration of fibers (longer than 5 micrometers) per cubic centimeter of air that represents the employee's 8-hour workday as determined by Appendix A of 29 CFR 1926.1101.

1.3. GENERAL REQUIREMENTS

The Third Party Air Monitoring Contractor (hereafter referred to as the TPAM Contractor) shall be completely independent from the Abatement Contractor and shall not be an employee of the Abatement Contractor or be an employee or principal of a firm recognized by Federal, state, or local regulations that would constitute a business relationship that would not be considered independent of the Abatement Contractor Scope of Work.

- A. The Air Traffic Control Tower is a 24 hour per day, 7 days per week facility. The TPAM Contractor shall provide all labor, material, and equipment necessary to accomplish the following:
 - 1. Provide professional services to review and comment on the Abatement Contractor's Asbestos Abatement Plan.
 - 2. If previously untested building components suspected to contain asbestos are observed and located in areas impacted by the abatement work, the TPAM Contractor shall notify the Contracting Officer's Technical Representative (COR) Contracting Officer Representative (COR) who will have the option of presuming the material

contains asbestos or directing the TPAM Contractor to collect up to [] bulk samples of the material. Analysis of bulk samples shall be performed using polarized light microscopy as specified by 40 CFR Part 763, Subpart E, Appendix C.

3. Develop two air monitoring plans for the asbestos abatement project. One will address area air monitoring inside of the regulated area and in FAA occupied areas outside the regulated area. The other plan will address personal air monitoring for FAA personnel outside the regulated work area. (See Attachments 1 and 2 for Air Monitoring Plans)
4. Conduct asbestos briefings for FAA employees during various phases of the abatement project.
5. Provide 24-hour air monitoring services and accomplish on-site analysis by Phase Contrast Microscopy (PCM) of samples to quantify fiber concentrations.
6. The contractor should provide analysis of air samples by an accredited laboratory Proficiency Analytical Testing (PAT) and/or American Industrial Hygiene Association (AIHA) and National Voluntary Laboratory Accreditation Program (NVLAP) utilizing Transmission Electron Microscopy (TEM) to quantify the airborne asbestos fiber concentration.
7. Provide services to measure and record pressure differentials 24 hours per day.
8. Provide professional services to accomplish full-time site inspection of asbestos removal activities, including daily written reports of such activities.
9. Attend and participate in on-site meetings, such as the preconstruction meeting, as required throughout the project.
10. Provide a "Final Report" to document that abatement activities were performed in compliance with Federal, state, local requirements and the asbestos abatement contract specifications.
11. Provide 24-hour pressure differential alarm monitoring.
12. Provide consultation pertaining to representative personal air monitoring by a CIH in the event the Facility Asbestos Abatement Contingency Plan is implemented.
13. Maintain daily activity logs, which shall be provided to the COR and SECM within 24 hours of request.

B. FAA Furnished Equipment

1. The FAA will not provide equipment or office space for use by the TPAM Contractor during the project.

B. Coordination

1. All Coordination between the TPAM Contractor and both the Abatement Contractor and Airway Facilities, shall be exclusively through the COR unless otherwise directed in writing by the Contracting Officer (CO).

C. Schedule of Work

1. Baseline samples will be collected 10 to 30 days prior to abatement. No activities will be allowed to proceed if baseline samples analyzed by PCM indicate fiber concentrations greater than 0.025 f/cc. If the results are greater than 0.025 f/cc, re-sampling and establishment of a new baseline will take place following re-cleaning by the abatement contractor. If baseline concentrations less than 0.025 f/cc cannot be achieved, the COR will obtain justification for approval by the FAA headquarters' CIH. The COR will be responsible for identifying the schedule for baseline samples to be collected.
2. All set-up work (e.g. enclosure construction, pre-cleaning) by the Abatement Contractor shall take place during off-hours between 11:00PM and 5:00AM. During abatement, all asbestos abatement shall take place after all enclosures have been erected and between the hours of 11:00PM and 5:00AM.
3. Analysis. Approximately one (1) additional hour 5:00AM to 6:00AM will be necessary to complete analysis of end of abatement shift samples and the daily log report.
4. Around the clock monitoring. Approximately one (1) additional hour prior to the work shift 10:00PM to 11:00PM will be necessary to complete analysis of off-work shift samples. Results shall be turned over to the COR prior to commencement of daily abatement activities.
5. Weekend/holiday. Samples will be collected and analyzed on-site in maximum of 12-hour cycles.

D. Safe Working Condition

1. All FAA and OSHA safety regulations must be observed and enforced at all times during the project to protect both FAA and TPAM Contractor employees from injury or illness.

E. Facility Security Requirements

1. The Air Traffic Control Tower is under security at all times. All critical areas (e.g. air traffic control towers) are controlled by means of a personal identification system. All personnel entering the facility will require a visitor badge, which must be worn while on the premises. Further instructions regarding security requirements will be furnished at the time the badges are issued. All Contractors and their employees will be required to sign site entry/exit log on a daily basis.

2. Sanitary Facilities. Rest rooms are located throughout the facility and will be made available for use by the TPAM Contractor's employees.
3. Cafeteria and/or Break Areas. Use of FAA cafeteria and break areas will be allowed.
4. Housekeeping. The TPAM Contractor shall keep the working area in a clean and proper condition. All rubbish and waste resulting from execution of the TPAM Contractor's work shall be removed at the end of each shift. Asbestos contaminated sampling waste shall be disposed of properly and will be combined with the waste generated by the Abatement Contractor.
5. Cleanup. Upon completion of the work, the TPAM Contractor shall remove his/her equipment, and unused supplies and materials.

1.4. DESCRIPTION OF WORK

NOTE: Provide TPAM Contractor a description of the scope of the abatement work. Include the specific location where the asbestos abatement work task is to occur (i.e., Building 1421, 2nd floor, Rm. 201.) Provide brief description of material to be abated; i.e., horizontal pipe, cement wall panels, tile, stucco, etc.

1.5. REQUIREMENTS

A. Medical Surveillance Examinations

1. Medical requirements shall conform to 29 CFR 1926.1101.

B. Exposure Data

1. The TPAM Contractor shall maintain complete and accurate employee exposure data on file at the work site as required by 29 CFR 1910.1020 and 29 CFR 1926.1101.

C. Certification, Accreditation and Training

NOTE: The asbestos training requirements have been delegated to EPA agreement states. Some states have adopted more stringent training requirements. Edit this paragraph in accordance with the most stringent requirement. Items referenced in brackets are subject to change based on local requirements.

1. Certification. All work under this contract shall be performed under the direction of an individual certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene.
 2. Accreditation. The independent laboratory and TPAM Contractor on-site analysts shall meet the requirements of the American Industrial Hygiene Association (AIHA), the Asbestos Analyst Registry (AAR), Proficiency Analytical Testing (PAT) Program, and the National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP) as applicable for the type of analysis performed.
 3. Training. All persons executing the duties under this contract shall have completed appropriate EPA Model Accreditation Program (MAP) training and required annual refresher courses as appropriate for the duties that will be performed under this contract. Updates will be done as required.
- B. The TPAM Contractor's CIH shall have completed an EPA MAP Asbestos Project Designer Training course.
- C. The TPAM Contractor's designated on-site oversight person shall meet the requirements of a Competent Person as outlined in 29 CFR 1926.1101. This person shall possess current EPA MAP certification as a Project Monitor and/or Contractor/Supervisor.
- D. PCM air sample analysts shall have completed NIOSH 582 or equivalent training.
- E. Personnel who collect bulk samples of suspect ACM shall have completed an EPA MAP Asbestos Inspector Training course.
- F. Related Work Experience:
1. The TPAM Contractor's CIH shall possess at least 3 years of experience in the asbestos abatement field.
 2. The TPAM Contractor's designated on-site oversight person shall possess at least 2 years of experience in the asbestos abatement field.
 3. Respiratory Protection Program
 - a. The TPAM Contractor's CIH shall establish in writing, and implement a respiratory protection program in accordance with 29 CFR 1926.1101, 29 CFR 1910.134, ANSI Z88.2, CGA G-7 and CGA G-7.1.
 4. Hazard Communication Program
 - a. A written hazard communication program shall be established and implemented in accordance with 29 CFR Section 1926.59.
 5. Site Specific Hazards
 - a. NOTE: Provide TPAM Contractor with requirements for addressing site-specific hazards that may be encountered with this work.
- G. Permits, Licenses and Notifications
- a. NOTE: Verify whether the city, county, state, and/or USEPA has jurisdiction, and whether licenses or permits are required.

H. Insurance

The Contractor shall purchase and maintain the following insurance coverage, with the stated minimum limits:

<u>Type of Coverage</u>	<u>Minimum Limit</u>
Automobile Liability	\$1 million per occurrence for bodily injury \$50,000 per occurrence for property damage
Worker's Compensation	\$1 million per occurrence
Errors & Omissions	\$1 million per occurrence
Professional Liability	\$1 million per occurrence

The policies evidencing required insurance shall be written on a comprehensive form of policy listing the FAA as the certificate holder. The policies shall also contain an endorsement to the effect that any cancellation or any material change adversely affecting the FAA's interest shall not be effective for such period as the laws of [State] allow or until 30 days after the insurer or the Contractor gives written notice to the CO, whichever period is longer. Each policy shall include a provision that the FAA will be notified at least 30 days in advance of the effective date of any reduction in coverage or cancellation.

I. Materials and Equipment

1. General: Unless otherwise stated herein, the TPAM Contractor shall provide all materials and equipment necessary to perform the work. This may include, but not be limited to: electrical cords, ground fault circuit interrupters, first aid kits, logbooks, log forms, markers with indelible ink, etc.
2. Air Monitoring: Air monitoring equipment furnished shall include, but not be limited to, high and low volume pumps, calibration equipment, chemical agents, quick fix and slides, and microscope with accessories. Upon approval of the Abatement Contractor's Asbestos Abatement Plan, the TPAM Contractor shall prepare two Air Monitoring Plans for the performance of all work required under this contract. The Area Air Monitoring Plan will include, at a minimum, the specifics of the 24 hours per day/7 days per week area air sampling plan, baseline sampling, and clearance sampling. The Personal Air Monitoring Plan shall address the implementation of the Facility Asbestos Abatement Contingency Plan at any time during the abatement project.

J. Pressure Differential Recordings

1. The TPAM Contractor shall furnish all equipment and personnel necessary to provide continuous, 24 hour/day, pressure differential monitoring in order to insure the Abatement Contractor's conformity with the requirements of the abatement contract. The TPAM Contractor's differential monitoring equipment will be calibrated and certified to the manufacturer's specification prior to the start of work. It shall be the TPAM Contractor's responsibility to routinely check their monitors at the beginning and end of each working day and twice per day during the removal activity. Pressure differential shall be remotely monitored with a 60-second time delay during removal activity. The COR must be notified should pressure differentials be less than 0.02 inches of water or above 0.05 inches of water. Pressure differentials greater than 0.05 inches of water must be approved by the COR and TPAM Contractor's CIH. At

no time shall pressure differential exceed 0.1 inches of water. Recordings shall be documented in the Daily Log.

2. Equipment. The monitors provided shall possess the following minimum features:
 - a. High and low limit alarm set points
 - b. Audible and visual alarm system
 - c. Alarm delay feature
 - d. LCD display showing inches of water column
 - e. Strip Chart Recorder (must include date and time)
 - f. + 1 % accuracy
3. The pressure differential monitoring equipment shall have the capacity to be remotely monitored to the FAA and Maintenance Control Center (MCC). The location will be coordinated with the facility. The purpose of the alarm is to alert FAA personnel who will page the TPAM Contractor should an immediate assessment of the regulated work area be necessary.

K. Rental Equipment

NOTE: If rental equipment is to be used, written notification shall be provided by the TPAM Contractor to the rental agency concerning the intended use of the equipment, the possibility of asbestos contamination of the equipment, and the steps that will be taken to decontaminate such equipment. A written acceptance of the terms of the TPAM Contractor's notification shall be obtained from the rental agency.

1.6. SUBMITTALS Note: The number and distribution of copies of submittals should be determined by the COR per local requirements.

A. Medical Examinations

1. Provide the physician's written opinions documenting completion of most recent medical examinations that verify the ability of the TPAM Contractor's employee's to work under the anticipated site conditions. This information must be provided to the COR at least 30 days prior to the start of work.

B. Exposure Data

1. There are no submittals required for exposure data.

C. Certification, Accreditation and Training

1. Certification. Provide proof of current certification of the Certified Industrial Hygienist who will direct all work under this contract to the COR with the bid. The CIH shall be an accredited Asbestos Project Designer.
2. Accreditation
 - a. Provide proof of successful participation in the last four (4) PAT program rounds by the parent lab of persons who will be performing the air monitoring services and fiber analysis to the COR with the bid package.

- b. The TPAM Contractor and independent laboratory shall provide proof of accreditation that all laboratories and onsite analysts meet the AIHA, the Asbestos Analyst Registry, PAT Program, NVLAP, and NIOSH 582 or equivalent with the bid package. Lack of such evidence will indicate failure to meet the requirements of this specification.
- 3. Training
 - D. Provide proof of current EPA training of all TPAM Contractor personnel executing the duties established by this contract to the COR at least 30 days prior to the start of work.
 - E. Provide proof that the oversight person meets the requirements of a “Competent Person” as outlined in 29 CFR 1926.1101 paragraph (b); has at least three years related experience, and possesses current EPA accreditation as a Contractor/Supervisor under AHERA [and/or] Project Monitor under state requirements to the COR at least 30 days prior to the start of work.
 - F. Related Work Experience for CIH and Industrial Hygienists/Industrial Hygiene Technicians. Submit resumes documenting work experience as required by paragraph 1.5.C to the CO with the bid package.
 - G. Respiratory Protection Program
 - 1. Provide a copy of the TPAM Contractor’s Respiratory Protection Program and documentation of respirator fit-tests to the COR at least 30 days prior to the start of work.
 - H. Hazard Communication Program
 - 1. Provide a copy of the TPAM Contractor’s Hazard Communication Plan and MSDSs for all hazardous chemicals to be used onsite to the COR at least 30 days prior to the start of work.
 - I. Site Specific Hazards
 - 1. Provide a Site Safety Plan to address the hazards provided in paragraph 1.5.F to the COR at least 30 days prior to the start of work.
 - J. Permits, Licenses and Notifications
 - 1. Provide necessary Federal, State, regional and local licenses, as required to perform environmental monitoring services to the COR at least 30 days prior to the start of work.
 - K. Insurance
 - 1. Provide original certificates of insurance to the [CO] with the bid.
 - L. Materials and Equipment
 - M. General. Provide a list of all equipment to be brought on site along with manufacturer’s specifications to the COR at least 30 days prior to the start of work.
 - N. Air Monitoring Equipment. Provide a list of all air monitoring equipment to be brought on site along with manufacturer’s specifications to the COR at least 30 days prior to the start of work.

O. Air Monitoring

1. Area and Personal Air Monitoring Plans. Upon approval of the Abatement Contractor's Asbestos Abatement Plan, the TPAM Contractor shall submit two Air Monitoring Plans for the performance of all work required under this section to the COR at least 10 days prior to the start of work.
2. Air Monitoring Results. Typically, verbal air sampling results will be provided to the COR within 1 hour from the time of analysis and written results will be provided within 24 hours. Results exceeding the specified stop work levels must be reported verbally within one hour of analysis with written results posted the next day. Final clearance air monitoring results shall be submitted within 10 days of collection of the samples.

P. Pressure Differential Recordings

1. Copies of strip chart recordings shall be provided to the COR daily.

Q. Rental Equipment

A copy of the written acceptance of the terms of the TPAM Contractor's notification to the rental agency shall be submitted to the COR at least [10] days prior to the start of work.

PART 2.0 – EXECUTION.

2.1. INSPECTIONS

A. Preliminary.

The TPAM Contractor shall thoroughly inspect the area where abatement will be performed prior to the start of work. The purpose of this preliminary inspection shall be to develop air-monitoring strategies and review the feasibility of the Abatement Contractor's Asbestos Abatement Plan with respect to actual site conditions.

B. Daily.

The TPAM Contractor shall conduct daily inspections of the Abatement Contractor's activities inside and outside of the asbestos regulated work area during each phase of abatement work. Such inspections shall be performed at least two times per shift inside of the asbestos regulated work area. Pre-cleaning, set-up work, abatement work practices, barrier/enclosure integrity, operation of negative air filtration units, and any other activities that may impact the intent of the asbestos abatement specifications or the Asbestos Abatement Plan shall be assessed. Smoke testing of enclosures shall be performed and documented prior to the start of abatement work. If activities or situations are observed that do not conform to the intent of the asbestos abatement specifications and/or Federal, State, or local regulations, the TPAM Contractor shall immediately notify the COR that corrective action is required.

C. Final Inspection.

1. Upon completion of abatement work and initial cleaning by the Abatement Contractor, the TPAM Contractor and COR shall conduct a visual inspection of the asbestos regulated work area in preparation for a final cleaning. Following approval

of the initial cleaning by the COR, the Abatement Contractor will perform a final cleaning of the work area. After final cleaning has been completed, the TPAM Contractor's onsite oversight person and COR shall conduct a final visual inspection of the cleaned asbestos regulated work area and complete the Final Cleaning and Visual Inspection form as specified by ASTM E 1368 (1997).

2.2. REVIEW OF ASBESTOS ABATEMENT PLAN

Services required in this contract include the review of the Abatement Contractor's Asbestos Abatement Plan by the TPAM Contractor's CIH. The TPAM Contractor shall review the Plan and provide a written approval or disapproval signed by a CIH. When the TPAM Contractor disapproves the Plan, the reviewer shall reference the appropriate regulation or specification section under which the Plan fails to comply and recommend amendments to the Plan.

2.3. BRIEFINGS

- A. The TPAM Contractor's CIH shall conduct four (4), 60-minute briefings at the Facility to inform the occupants of work places adjoining the asbestos control areas about various aspects of the project including:
 - 1. Purpose and scope of the project.
 - 2. Location of the work, regulated areas, and alternate routes for foot traffic and fire escape.
 - 3. Health aspects of asbestos exposure.
 - 4. OSHA Asbestos Standards.
 - 5. Protective measures that will be utilized.
 - 6. Monitoring program to determine level of airborne asbestos and differential pressures.
 - 7. Inspection procedures to verify asbestos removal and the Abatement Contractor's compliance with safety precautions.
 - 8. Condition/situations that warrant notification to the COR for potential work stoppage.
- B. Briefings shall be scheduled two per day, on two consecutive days. They shall be conducted approximately 10 days prior to the start of any asbestos related construction activity.
- C. On-site Meeting: The TPAM Contractor shall attend, and participate in on-site construction meetings such as the pre-construction meeting throughout the duration of the project. The asbestos portion of each meeting will be summarized and documented in the project log.

2.4. MONITORING NEGATIVE PRESSURE

- A. The TPAM Contractor shall monitor, document, and report to the COR that the containment has been under negative pressure for a constant period of no less than 24 hours before abatement starts. If the containment is found to be unacceptable, the TPAM Contractor shall provide recommendations for corrective action to the COR.

- B. The TPAM Contractor shall immediately notify the COR of any and all alarm conditions (as established in the Facility Asbestos Abatement Contingency Plan). The TPAM Contractor shall conduct inspections in the containment and perform negative pressure differential monitoring at least 2 times per shift. These inspections and pressure differential readings will be noted in the daily logbook.
- C. The strip charts shall be set up in a way that they are “time traceable”, i.e. while looking at a strip chart, one will be able to instantaneously determine the date and the exact time of day when a given pressure reading was recorded.
- D. During off hours, the Environmental Monitoring Contractor shall verbally respond after 30 minutes of being contacted by the FAA and shall be onsite to perform an assessment not later than 60 minutes from the time of the initial page.

2.5. STOP WORK The TPAM Contractor shall immediately notify the COR of the following conditions. This will be sufficient evidence for the COR to direct the Abatement Contractor to stop work and take corrective action as outlined in the Facility Asbestos Abatement Contingency Plan.

- A. If air sampling and analysis conducted in accordance with these specifications and the TPAM Contractor’s approved Area Air Monitoring Plan indicates airborne fiber concentrations of 0.02 f/cc above baseline or greater outside of the asbestos regulated work area.
- B. If the TPAM Contractor measures pressure differentials less than 0.02 inches of water or greater than 0.05 inches of water inside the containment of the asbestos work area.
- C. Work or conditions found to be in violation of this specification or applicable regulations. This includes, but is not limited to, puncture or collapse of containment barriers, electrical power loss, ground-fault circuit interrupter failure, equipment failure, dry removal of ACM, and visible emission from the asbestos regulated work area.
- D. Any other condition that may adversely impact or disrupt flying operations or working conditions at the facility.

2.6. AIR SAMPLING

Sampling and analysis of airborne concentrations of asbestos fibers shall be performed in accordance with the TPAM Contractor's approved air monitoring plans and as specified herein. For area sampling during asbestos abatement work, NIOSH Pub No. 84-100 Method 7400 (PCM) with optional confirmation of results by NIOSH Pub No. 84-100 Method 7402 Transmission Electron Microscopy (TEM)] shall be used. All area sampling will be conducted at a sufficient flow rate and time to collect a sample volume necessary to establish the limit of detection of the method used at 0.01 f/cc. The sampling and analytical method used for final clearance air sampling will be NIOSH 7400 with optional confirmation of results using NIOSH Method 7402. For personal sampling required by 29 CFR 1926.1101, NIOSH Method 7400 or equivalent shall be used for sampling and Phase Contract Microscopy (PCM) analysis. Asbestos fiber concentration confirmation of the total fiber concentration results of samples collected and analyzed by NIOSH Method 7400 may be conducted. In cases where confirmation is required, analysis shall be carried out using transmission electron microscopy in accordance with NIOSH Method 7402. When such

confirmation is conducted, it shall be from the same sample filter used for the NIOSH Method 7400 PCM analysis. Prior approval of the FAA is required for confirmatory analysis. All confirmatory analysis shall be at the FAA's expense. The FAA may duplicate monitoring at the discretion of the Contracting Officer. The Environmental Monitoring Contractor shall archive sampling cassettes for the duration of the project plus 6 months.

2.7. SAMPLING PRIOR TO ASBESTOS WORK (BASELINE SAMPLES)

The baseline air sampling shall be established 1-30 days prior to the masking and sealing operations for each abatement area site. Pre-abatement air samples shall be collected at a minimum of five locations. These locations are: Outside the building, inside the building, but outside the abatement area and inside each abatement area. One sample shall be collected for each 10,000 cubic feet (ft³) of total area in the abatement work area. One additional sample shall be collected for each 5,000 ft³ of area over 10,000 ft³. Baseline samples will be collected from adjacent areas per the Facility Asbestos Abatement Contingency Plan. The samples shall be analyzed immediately using NIOSH Method 7400 (PCM). If any of the samples result in fiber concentration greater than 0.025 f/cc, asbestos fiber concentration shall be confirmed using NIOSH Method 7402 (TEM) at FAA expense.

2.8. SAMPLING DURING ASBESTOS ABATEMENT WORK AND OFF-SHIFT HOURS

The TPAM Contractor shall provide area sampling as indicated in 29 CFR 1926.1101, state and local requirements, and in accordance with the approved air monitoring plans. Area sampling shall be conducted at least once every shift, close to the work in the containment area, outside the clean room entrance to the containment area, (outside air lock for mini and modified containment areas), inside the clean room (inside the air lock for mini and modified containment areas), outside the load-out unit exit, if used, and at an exhaust discharge point of the local exhaust system. In areas where the construction of a containment area is not required, after initial time weighted average (TWA) airborne fiber concentrations are established, and provided the same type of work is being performed, the PCM sampling shall be conducted at the boundary of the asbestos regulated work area in such locations and frequency, as stated in the approved air monitoring plan.

2.9. SAMPLING AFTER FINAL CLEAN-UP (FINAL CLEARANCE SAMPLING)

The following clearance section shall be incorporated into asbestos abatement project specification. This section shall remain in effect until the FAA National Policy is coordinated and adopted.

A. Final Cleaning and Inspections

Typically, final clearance air monitoring shall not begin until 24 hours after completion of final cleaning. In cases where time is critical, the discretion of the CIH and COR shall be allowed. The collection of samples before adequate drying of the lockdown may result in invalid clearance sample results.

Prior to conducting final air clearance monitoring, the TPAM Contractor and the COR shall conduct a final visual inspection of the Abatement Contractor's final cleanup of the abated asbestos regulated work area. After COR acceptance of the final cleaning, the

COR will direct the Abatement Contractor to apply the lockdown encapsulant. Final clearance air monitoring shall not begin until 24 hours after COR acceptance of lockdown encapsulant application. The TPAM Contractor will provide area sampling of airborne fibers using aggressive air sampling techniques described in 40 CFR Part 763, Appendix A to Subpart E. The collected samples shall be analyzed using Transmission Electron Microscopy (TEM) by a laboratory that participates in the National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP).

B. Final Clearance Criteria

The final clearance air samples shall be collected under aggressive sampling conditions as defined in 40 CFR Part 763, Appendix A to Subpart E. A minimum of 5 area air samples shall be collected inside each contiguous abatement work area. A minimum of 5 area air samples per ambient area positioned at locations representative of the air entering the abatement site shall be collected. Two (2) field blanks are to be taken by removing the cap for not more than 30 seconds and replacing it at the time of sampling before sampling is initiated at the entrance to each abatement area and at one of the ambient sites. A sealed blank is to be carried with each sample set. The work area shall be considered clean when all 5 inside samples are at or below 0.005 asbestos structures per cubic centimeter (St/cc) of air. No averaging of results shall be used. The recommended volume of air for each sample shall be 1800 liters of air. The final clearance results shall also indicate that each sample is at or below 70 structures per square millimeter (St/mm²).

C. Air Clearance Failure

The Asbestos Abatement Contractor shall repeat final cleaning procedures at no additional cost to the Government if any sample exceed the clearance criteria in 2.9.B. Failure to meet final clearance criteria for any individual sample, will require the Asbestos Abatement Contractor to pay all cost associated with additional cleaning requirements and the cost of all additional sampling and TEM analysis. If one sample fails the final clearance criteria, the complete set of samples identified in paragraph 2.9.B shall be repeated.

END OF SECTION

ATTACHMENT 1: MODEL AREA AIR SAMPLING PLAN

- The TPAM Contractor shall conduct baseline sampling sufficient to document conditions prior to abatement in each room/area to be abated and in all perimeter areas that will be included during off-shift monitoring periods. At least one baseline sample shall be collected for each 10,000 ft³ of total area inside of each area that will be abated.
- The TPAM Contractor's work hours will be from 7 AM – 4 PM . During this time, samples will be collected as follows and the results reported to the appropriate personnel within one hour after analysis: Area sampling shall be conducted at least once every shift in the following locations: close to the work in the containment area, outside the clean room entrance to the containment area, (outside air lock for mini and modified containment areas), inside the clean room (inside the air lock for mini and modified containment areas), outside the load-out unit exit, if used, and at the exhaust discharge point of the local exhaust system.
- Off-shift sampling shall be conducted as follows: One hour after completion of the abatement work shift all area air pumps (minimum of eight) will be set up and allowed to run until one hour prior to the beginning of the next shift. No more than 3,000 liters of air will be collected for any off-shift samples. If sampling is to take place in a dusty area, the flow rate will be reduced by a sufficient amount to ensure that the samples do not become overloaded. Analysis of off-shift samples will be by NIOSH Method 7400 (PCM).
- During periods of no Abatement Contractor work activity, for example weekends, sampling will be conducted in a maximum of 12-hour cycles. For example the TPAM Contractor will arrive on-site at 0600 and place samples. Twelve hours later, at 1800, the TPAM Contractor will return to collect the samples and place new samples to be collected at 0600 the following day. The shift will be 1800 to 2000 and 0600 to 0800 on these days.
- Clearance sampling shall be conducted in accordance with EPA Publication 560/5-85-024. A minimum of 5 samples will be collected inside the abatement area. If the work area is larger than 10,000 ft³, one additional sample will be collected for every 5,000 ft³. For instance, a 12,000 ft³ work area would require 6 samples and a 26,000 ft³ work area would require 9 samples. Decontamination of the abated asbestos regulated work area will be considered complete when each of the 5 samples is analyzed as containing less than 0.01 fibers per cubic centimeters of air using NIOSH Method 7400 (PCM).

WEEKDAY/ CONTRACTOR'S WORK DAY SCHEDULE

Start Time	Location	Flow Rate (liters/minute)	Stop Time	Volume (liters)	Results Reported
2000	A	10.0	2200	1200	2300
2000	B	9.0	2300	1620	0000
2000	C	8.0	0000	1920	0100
2000	D	7.0	0100	2100	0200
2000	E	6.0	0200	2160	0300
2000	F	5.0	0300	2100	0400
2000	G	4.0	0400	1920	0500
2000	H	3.0	0500	1620	0600
2200	A	4.0	0600	1920	0700
2300	B	5.0	0600	2100	0700
0000	C	6.0	0600	2160	0700
0100	D	7.0	0600	2100	0700
0200	E	8.0	0600	1920	0800
0300	F	9.0	0600	1620	0800
0400	G	10.0	0600	1200	0800
0500	H	3.0	2000	2700	2100
0600	A	3.0	2000	2520	2100
0600	B	3.0	2000	2520	2100
0600	C	3.0	2000	2520	2100
0600	D	3.0	2000	2520	2100
0600	E	3.0	2000	2520	2200
0600	F	3.0	2000	2520	2200
0600	G	3.0	2000	2520	2200

WEEKEND/ NON-CONTRACTOR WORK DAYS

Start Time	Location	Flow Rate (liters/minute)	Stop Time	Volume (liters)	Results Reported
0600	A	3.0	1800	2160	2000
0600	B	3.0	1800	2160	2000
0600	C	3.0	1800	2160	2000
0600	D	3.0	1800	2160	2000
0600	E	3.0	1800	2160	2000
0600	F	3.0	1800	2160	2000
0600	G	3.0	1800	2160	2000
0600	H	3.0	1800	2160	2000
1800	A	3.0	0600	2160	0800
1800	B	3.0	0600	2160	0800
1800	C	3.0	0600	2160	0800
1800	D	3.0	0600	2160	0800
1800	E	3.0	0600	2160	0800
1800	F	3.0	0600	2160	0800
1800	G	3.0	0600	2160	0800
1800	H	3.0	0600	2160	0800

ATTACHMENT 2: MODEL PERSONAL AIR SAMPLING PLAN

In the event of perimeter air sample results at or above 0.02 fibers per cubic centimeter of air (f/cc) above baseline or if it is expected that the permissible exposure limit (PEL) of 0.1 f/cc will be reached or exceeded, the TPAM Contractor will notify FAA employees occupying the affected area. The TPAM Contractor will notify the COR when fiber counts exceed 0.02 f/cc above baseline. Notification will be performed in accordance with the Facility Asbestos Abatement Contingency Plan, Figure 1 Emergency Response Flow Chart. If perimeter air sampling results exceed 0.1 f/cc, the Facility Asbestos Abatement Contingency Plan and the personal monitoring program described below will be implemented:

Area Of The Facility	Number Of Personal Samples As Representative
Control Room – STMCIC (including weather and flight data)	1 to 2
Control Room per 5 Bay Areas	1 for the Supervisor and 1 AT Controller per area of specialization
Control Room – NOM	1
Outside of the Control Room – (Auto Wing, Communication, or AF Technicians, etc.)	1 per affected area
Other Personnel	At the discretion of the IH

The first personal sample will be a 30-minute excursion sample and remaining samples may be 30-minute excursion or representative of the full shift exposure of FAA employees. The personnel chosen for monitoring will be identified based on the following criteria: 1) The personnel most at risk of exposure by their proximity to released asbestos; 2) The personnel most likely to remain in the control room the longest; 3) The personnel who are most likely to stay in one area to work; and 4) The personnel willing to volunteer for the suggested sampling.

The TPAM Contractor will be responsible for the maintenance, calibration, and proper use of personal air monitoring equipment and adhering to the National Institute for Occupational Safety and Health (NIOSH) 7400 Method or equivalent for phase contrast microscopy (PCM). TPAM Contractor PCM analysts will be listed in the American Industrial Hygiene Association's Asbestos Analytical Registry. Any transmission electron microscopy (TEM) analysis will utilize the NIOSH 7402 Method and be performed by a laboratory accredited by the American Industrial Hygiene Association.

Samples will be collected per OSHA technical field manual protocols.

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SECTION 02 82 33 - REMOVAL AND DISPOSAL OF ASBESTOS CONTAINING MATERIALS

PART 1 GENERAL

1.1 REFERENCES

The latest edition of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z88.2 Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR) PUBLICATIONS:

40 CFR 61, Subpart A	General Provisions
40 CFR 61, Subpart M	National Emission Standard for Asbestos
40 CFR 241	Guidelines for the Land Disposal of Solid Wastes
40 CFR 257	Criteria for Classification of Solid Waste Disposal Facilities and Practices
40 CFR 763	Asbestos Abatement Projects Rule

MANUAL OF ANALYTICAL METHODS, 3RD ED., VOL. 1, PHYSICAL AND CHEMICAL ANALYSIS METHOD (P&CAM)

Method 7400	Fibers
Method 7402	Asbestos Fibers

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

29 CFR 1926.1101	Asbestos Construction Standard
29 CFR 1910.1001	Asbestos General Industry Standard
29 CFR 1910.132	Personal Protection Equipment
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.145	Accident Prevention Signs and Tags

UNDERWRITERS LABORATORIES, INC. (UL) PUBLICATIONS

UL 586

High Efficiency Particulate, Air Filter

1.2 DESCRIPTION OF WORK

The work covered by this section includes possible handling of friable and nonfriable materials containing asbestos which may be encountered during removal and demolition operations and the incidental procedures and equipment required to protect workers and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any removed asbestos-containing materials. Perform work in accordance with 29 CFR 1926.1101; 40 CFR 61, Subpart A; 40 CFR 61, Subpart M; and the requirements specified herein. The potential asbestos work will be included in the demolition of the existing ATCT. Any ACM demolition will be included in the demolition of the tower. Appendices include previous reports and building plan information. Based on included reports the previously identified ACM may already have been removed.

1.2.1 Asbestos Survey

Previous asbestos Surveys were conducted in the contract work area(s) to identify the presence of asbestos containing materials as described in 1.2 above. The data collected is contained in the Construction Demolition Drawings.

1.2.2 Unidentified ACM

If ACM not identified by the ASBESTOS SURVEY REPORTS, the drawings or the specifications is encountered, the Contractor shall stop work and immediately notify the Contracting Officer Representative. Upon direction from the Contracting Officer Representative, the Contractor may be required to conduct sampling and testing of these suspect materials in accordance with the Industrial Hygienist's recommended procedures. Payment for this additional work will be as per the contract clauses.

1.3 DEFINITIONS

1.3.1 Action level

An airborne concentration of asbestos of 0.1 fiber (longer than 5 micrometers) per cubic centimeter (f/cc) of air calculated as an eight-(8)-hour time weighted-average (TWA).

1.3.2 Aggressive method

Removal or disturbance of building material by sanding, abrading, grinding or other method that breaks, crumbles, or disintegrates intact Asbestos Containing Material (ACM).

1.3.3 Amended Water

Water containing a wetting agent or surfactant.

1.3.4 Area Monitoring

Sampling of asbestos fiber concentrations within the regulated area and outside the regulated area which is representative of the airborne concentrations of asbestos fibers which may reach the breathing zone.

1.3.5 Asbestos

Includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that has been chemically treated and/or altered. For purposes of this standard, "asbestos" includes PACM, as defined below.

1.3.6 Asbestos Abatement Contractor

A business entity certified, licensed, or accredited by the state in which a response action involving asbestos-containing building material that is friable, or expected to become friable during the response action, is undertaken.

1.3.7 Asbestos Containing Material (ACM)

Material composed of asbestos of any type and in an amount greater than 1 percent by weight, either alone or mixed with other fibrous or nonfibrous materials.

1.3.8 Asbestos Fibers

Asbestos fibers having length-to-diameter ratio of at least 3 to 1 and 5 micrometers or longer as counted in the NIOSH Method 7400 or Method 7402 procedure using either phase contrast light microscopy (PCM) or transmission electronic microscopy (TEM).

1.3.9 Asbestos Permissible Exposure Limit (PEL)

Exposure to an airborne concentration of asbestos fibers not to exceed 0.1 fiber per cubic centimeter of air as an eight-(8)-hour time weighted average (TWA).

1.3.10 Authorized Person

Any person authorized and required by work duties to be present in regulated areas.

1.3.11 Breathing Zone

A hemisphere forward of the shoulders with a radius of approximately 6 inches to 9 inches.

1.3.12 Category I Nonfriable ACM

Category I Nonfriable ACM includes asbestos-containing packing, gaskets, resilient floor covering, and asphalt roofing products.

1.3.13 Category II Nonfriable ACM

Category II Nonfriable ACM includes any asbestos-containing material not included in Category I that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

1.3.14 Certified Industrial Hygienist (CIH)

One certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene.

1.3.15 Class I Asbestos Work

Activities involving the removal of Thermal System Insulation (TSI) and surfacing ACM and PACM.

1.3.16 Class II Asbestos Work

Activities involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but it not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.

1.3.17 Class III Asbestos Work

Repair and maintenance operations, where "ACM", including thermal system insulation and surfacing material, is likely to be disturbed.

1.3.18 Clean Room

An uncontaminated room having facilities for storage of employees' street clothing and uncontaminated materials and equipment.

1.3.19 Competent Person

In addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32 (f); in addition, for Class I and Class II work, one who is specially trained in a training course which meet the criteria of EPA's Model Accreditation Plan (40 CFR 763) for project designer or supervisor, or its equivalent and, for Class II who is trained in an operations and maintenance (O&M) course developed by EPA (40 CFR 763.92 (a)(2)).

1.3.20 Critical Barrier

One or more layers of plastic sealed over all openings into a work area or any other similarly placed physical barrier sufficient to prevent airborne asbestos in work area from migrating to an adjacent area.

1.3.21 Decontamination Area

An enclosed area adjacent and connected to the regulated area and consisting of an equipment room, shower area, and clean room which is used for the decontamination of workers, materials and equipment contaminated with asbestos.

1.3.22 Demolition

The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

1.3.23 Disturbances

Contact which releases fibers from ACM or PACM or debris containing ACM or PACM. This term includes activities that disrupt the matrix of ACM or PACM, render ACM or PACM friable, or generate visible debris. Disturbance includes cutting away small amounts of ACM and PACM, no greater than the amount which can be contained in one standard sized glove bag or waste bag in order to access a building component. In no event shall the amount of ACM or PACM so disturbed exceed that which can be contained in one glove bag or waste bag which shall not exceed 60 inches in length and width.

1.3.24 Employee Exposure

That exposure to airborne asbestos that would occur if the employee were not using respiratory protective equipment.

1.3.25 Encapsulant

A liquid material which can be applied to ACM which controls the possible release of asbestos fibers from the material either by creating a membrane over the surface (bridging encapsulant) or by penetrating into the material and binding its components together (penetrating encapsulant).

1.3.26 Encapsulate

The process whereby an encapsulant is applied to ACM to control the release of asbestos fibers into the air.

1.3.27 Equipment Room (Change Room)

A contaminated room located within the decontamination area that is supplied with impermeable bags or containers for the disposal of contaminated protective clothing and equipment.

1.3.28 Fiber

A particulate form of asbestos, 5 micrometers or longer, with a length-to-diameter ratio of at least 3 to 1.

1.3.29 Friable Asbestos Material

Material that contains more than 1 percent asbestos by weight which can be crumbled, pulverized, or reduced to powder by hand pressure when dry.

1.3.30 Glovebag Technique

A method with limited applications for removing small sections of asbestos-containing material from HVAC ducts, short piping runs, valves, joints, elbows, and other nonplanar surfaces in a non-contained regulated area. The glovebag is constructed and installed in such a manner that it surrounds the object or material to be removed and contains all asbestos fibers released during the removal process. All workers

who are permitted to use the glovebag technique must be highly trained, experienced, and skilled in this method.

1.3.31 Glovebag

An impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled. Shall be made of 6 mil thick plastic and shall be seamless at the bottom.

1.3.32 HEPA Filter Equipment

High-efficiency particulate air (HEPA) filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometer diameter particles or larger.

1.3.33 Homogeneous Area

An area of surfacing material or thermal system insulation that is uniform in color and texture.

1.3.34 Intact

ACM which has not been crumbled, pulverized, or otherwise deteriorated so that it is no longer likely to be bound with its matrix.

1.3.35 Negative Initial Exposure Assessment

A demonstration which complies with the criteria in this section, that employee exposure during an operation is expected to be consistently below the PEL's.

1.3.36 Nonfriable Asbestos Material

Material that contains asbestos in which the fibers have been locked in by a bonding agent, coating, binder, or other material so that the asbestos is well bound and may not release fibers in excess of the action level during any appropriate use, handling, storage, transportation, or processing. Nonfriable asbestos material is considered hazardous during removal and disposal procedures.

1.3.37 (PACM) Presumed Asbestos Containing Material

Thermal system insulation and surfacing material found in buildings constructed no later than 1980.

1.3.38 Personal Monitoring

Sampling of airborne asbestos fiber concentrations within the breathing zone of an employee.

1.3.39 Prior Experience

Experience required of the Contractor, his employees, and his Industrial Hygienist on asbestos projects of similar nature and scope to ensure capability of performing the asbestos removal in a satisfactory manner.

Similarities shall be in areas related to material composition, project size, number of employees and the engineering work practice and personal protection controls required.

1.3.40 Regulated Areas

An area established to demarcate areas where Class I, II and III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work accumulate; and a work area within which airborne concentrations of asbestos, exceed or there is a reasonable possibility they may exceed the permissible exposure limit.

1.3.40.1 Enclosed Regulated Area

A regulated area which has been isolated by physical boundaries to prevent the spread of asbestos dust, fibers, or debris. A local exhaust system is required.

1.3.41 Regulated Asbestos-Containing Material (RACM)

- (a) Friable asbestos material
- (b) Category I nonfriable ACM that has become friable
- (c) Category I nonfriable ACM that will become or has been subjected to sanding, grinding, cutting, or abrading; and
- (d) Category II nonfriable ACM that has a high probability of becoming crumbled, pulverized, or reduced to powder by the forces acting on the material in the course of the demolition or renovation operation.

1.3.42 Thermal System Insulation (TSI)

ACM applied to pipes, fittings, boilers, breeching, tanks, ducts, or other structural components to prevent heat loss or gain.

1.3.43 Thermal System Insulation ACM

Thermal system insulation which contains more than 1% asbestos.

1.3.44 Time Weighted Average (TWA)

The TWA is an 8-hour time weighted average of airborne concentration of fibers per cubic centimeter of air.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section "SUBMITTALS" and approved by the Contracting Officer Representative prior to commencing any work involving asbestos materials:

SD-01: Data

Local Exhaust Equipment

HEPA Vacuum Equipment

Respirators

SD-08: Statements

Testing Laboratory

Submit the name, address, and telephone number of the testing laboratory selected to perform the monitoring, testing, and reporting of airborne concentrations of asbestos fibers along with certification that persons counting the samples have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program.

Industrial Hygienist

Submit the name, address, and telephone number of the Industrial Hygienist selected to prepare the asbestos plan, direct monitoring and perform training, and a certification that the Industrial Hygienist is certified by the American Board of Industrial Hygiene, including certification number and date and is experienced in asbestos removal activities.

Prior Experience

- (1) As evidence that the asbestos removal effort will be accomplished by trained and competent personnel totally familiar with safe and legal asbestos working practices, the Contractor shall furnish for Government approval (for himself or for his selected asbestos removal subcontractor) written demonstration of successfully completed asbestos abatement projects of similar nature and scope. A short summary of three (3) asbestos abatement projects performed shall include:
- a. The name, address, and telephone number of the contact person (someone specifically familiar with the Contractor's work). If available, include copies of letters of reference from previous users of service.
 - b. A short description of the type of removal (e.g. pipe lagging, sprayed girders and/or ceilings, transite siding, etc.), its extent (square feet, linear feet), and days to complete (scheduled and actual),
 - c. Documentation of any licenses or certifications as an asbestos abatement Contractor in the jurisdiction covered. If none, a negative response is required.
 - d. The Contractor shall certify that the firm and its employees are familiar with regulations of the Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA) cited in the project specification and related to asbestos abatement.
 - e. The Contractor shall further document that at least one on-site representative, such as a foreman or management-level person or other authorized representative, trained in the provisions of this regulation and the means of complying with them, is present. Every 2 years, the trained on-site individual shall receive refresher training in the provisions of this regulation. The required training shall include as a minimum: applicability; notifications; material identification; control procedures for removals including, at least, wetting, local exhaust ventilation, negative pressure enclosures, glove-bag procedures, and High Efficiency Particulate Air (HEPA) filters; waste disposal work practices; reporting and recordkeeping; and asbestos

hazards and worker protection. Evidence that the required training has been completed shall be posted and made available for inspection by the NESHAPS-administering agency at the demolition or renovation site.

f. A notarized statement, signed by an officer of the asbestos abatement company, containing the following information: (If none, a negative reply is required.)

- (2) A record of any citations issued by Federal, State, or local regulatory agencies relating to asbestos abatement activity. Include projects, dates and resolutions.
- (3) A list of penalties incurred through noncompliance with asbestos abatement project specifications including liquidated damages, overruns in scheduled time limitations and resolutions.
- (4) Situations in which an asbestos related contract has been terminated including projects, dates and reasons for terminations.
- (5) A listing of any asbestos-related legal proceedings/claims in which the Contractor (or employees scheduled to participated in this project) have participated or are currently involved. Include descriptions of role, issue and resolution to date.

Asbestos Plan

Submit a detailed Plan of the work procedures to be used in the removal and disposal of materials containing asbestos and include an explanation of the Initial Exposure Assessment. The Plan shall be prepared, signed, and sealed, including certification number and date, by the Contractor's Industrial Hygienist. Such Plan shall include a sketch showing the location, size, and details of regulated areas, location and details of the decontamination area, layout of decontamination area, and locations of local exhaust equipment. The Plan shall also include interface of trades involved in the construction, sequencing of asbestos-related work, abatement work, safety, and disposal plan, signage details, type of wetting agent to be used, air monitoring, respirators, protective equipment, pressure differential monitoring device, a disconnection schedule of utility services (where applicable), and a detailed description of the method employed in order to control pollution. The Plan shall be approved by the Contracting Officer Representative prior to the start of any asbestos work. Prior to beginning work, the Contractor shall meet with the Contracting Officer Representative to discuss in detail the Asbestos Plan, including work procedures and safety precautions.

Material Safety Data Sheets (MSDS)

Hazard Communication Plan

Notification Requirements

a. Initial Notification

The Contractor shall:

- (1) Provide the U.S. Environmental Protection Agency (EPA) Regional NESHAPS-administering agency with the notice of intention to demolish or renovate at least 10 business days prior to intended start date of the abatement. Copies of this form and any renotification forms shall be furnished to the Contracting Officer Representative. Work shall not commence on any dates other than those stated in the notification without renotification of all parties.

Delivery of the notice by U.S. Postal Service, commercial delivery service, or hand delivery is acceptable.

(2) Update notice, as necessary, including when the amount of asbestos affected changes by at least 20 percent.

(3) Postmark or deliver the notice as follows:

At least 10 working days before asbestos stripping or removal work or any other activity begins such as site preparation that would break up, dislodge or similarly disturb asbestos material.

b. Renotification

For asbestos stripping or removal work in a demolition or renovation operation that will begin on a date other than the one contained in the original notice, notice of the new start date must be provided to the NESHAPS-administering agency as follows:

(1) When the asbestos stripping or removal operation or demolition operation covered by this paragraph will begin after the date contained in the notice,

(a) Notify the NESHAPS-administering agency of the new start date by telephone as soon as possible before the original start date, and

(b) Provide the NESHAPS-administering agency with a written notice of the new start date as soon as possible before, and no later than, the original start date. Delivery of the updated notice by the U.S. Postal Service commercial delivery service, or hand delivery is acceptable.

(2) When the asbestos stripping or removal operation or demolition operation covered by this paragraph will begin on a date earlier than the original start date, provide the NESHAPS-administering agency with a written notice of the new start date at least 10 working days before asbestos stripping or removal work begins.

(3) In no event shall an operation covered by this paragraph begin on a date other than the date contained in the written notice of the new start date.

c. Notification Information

The following shall be included in the notice:

(1) An indication of whether the notice is the original or a revised notification.

(2) Name, address, and telephone number of both the facility owner and operator and the asbestos removal contractor.

(3) Type of operation: demolition or renovation.

(4) Description of the facility or affected part of the facility including the size (square feet and number of floors), age, and present and prior use of the facility.

(5) Procedure, including analytical methods, employed to detect the presence of RACM and Category I and Category II nonfriable ACM.

(6) Estimate of the approximate amount of RACM to be removed from the facility in terms of length of pipe in linear feet, surface area in square feet on other facility components, or volume in cubic feet if off the facility components. Also, estimate the approximate amount of Category I and Category II nonfriable ACM in the affected part of the facility that will not be removed before demolition.

(7) Location and street address (including building number or name and floor or room number, if appropriate), city, county, and state, of the facility being demolished or renovated.

(8) Description of procedures to be followed in the event that unexpected RACM is found or Category II nonfriable ACM becomes crumbled, pulverized, or reduced to powder.

SD-09: Reports

Monitoring Results

Fiber counting shall be completed, and results reviewed by the Industrial Hygienist within 16 hours of air sample collection. The Industrial Hygienist shall notify the Contractor and the Contracting Officer Representative immediately of any exposures to fibers in excess of the acceptable limits. Submit monitoring results to the Contracting Officer Representative within 3 working days, signed by the testing laboratory employee performing air monitoring, the employee that tested the sample, and the Industrial Hygienist.

Job Progress Report

During abatement activities, the Industrial Hygienist shall submit a weekly job progress report to the Contracting Officer Representative detailing abatement activities. Include review of progress with respect to Asbestos Plan, milestones and schedules, major problems and actions taken, injury reports, equipment breakdown and a compilation of the week's bulk material and air sampling results conducted by the Contractor's Industrial Hygienist or air sampling professional. Submission of individual monitoring results will be as dictated by SD-09, Reports. The progress report shall be signed by the Contractor, asbestos abatement subcontractor and the Industrial Hygienist.

SD-18: Records

Landfill Delivery Records

Submit written evidence that the landfill for disposal is approved for asbestos disposal by the state and local regulatory agencies. Submit copies of all waste shipment records and resulting correspondence.

1.5 TITLE TO MATERIALS

Materials resulting from demolition work, except as specified otherwise, shall become the responsibility of the Contractor and shall be disposed of as specified herein.

1.6 PROTECTION OF EXISTING WORK TO REMAIN

Perform demolition work without damage or contamination of adjacent work. Where such work is damaged or contaminated, restore work to the original condition.

1.7 SEQUENCE OF WORK

No other work shall be performed in the asbestos regulated area prior to completion and certification of the asbestos abatement work.

1.8 PERMISSIBLE EXPOSURE LIMITS (PELS)

- a. Time-weighted average limit (TWA). Ensure that no employee is exposed to an airborne concentration of asbestos in excess of 0.1 fiber per cubic centimeter of air as an eight (8) hour time-weighted average (TWA).
- b. Excursion limit. Ensure that no employee is exposed to an airborne concentration of asbestos in excess of 1.0 fiber per cubic centimeter of air (1 f/cc) as averaged over a sampling period of thirty (30) minutes.

1.9 MEDICAL SURVEILLANCE 29 CFR 1926.1101(m)

1.9.1 Medical examinations

Institute a medical surveillance program for all employees who for a combined total of 30 or more days per year are engaged in Class I, II and III work or are exposed at or above the permissible exposure limit or excursion limit, and for employees who wear negative pressure respirators. The content of the examination shall be consistent with 29 CFR 1926.1101 (m). This examination is not required if adequate records show the employee has been examined as required by 29 CFR 1926.1101 (m) within the past year. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos fibers and within 30 calendars days before or after the termination of employment in such occupation.

1.9.2 Medical Records

Maintain complete and accurate records as required by 29 CFR 1926.1101(n) employees' medical examinations for a period of at least 30 years after termination of employment and make records of the required medical examinations available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health, The Director of the National Institute for Occupational Safety and Health (NIOSH), authorized representatives of either, and an employee's physician upon the request of the employee or former employee.

1.10 TRAINING

Each employee must have received an equivalent level of training within 3 months prior to assignment to asbestos work or shall be instructed for a minimum of 8 hours by the Industrial Hygienist with regard to the methods of recognizing asbestos; the health effects associated with asbestos; the relationship between smoking and asbestos in producing lung cancer; its purposes, proper use, fitting instructions, and limitations of respirators; the nature of operations that could result in exposure to asbestos, the importance of necessary protective controls to minimize exposure and any necessary instructions in the use of these controls and procedures; the appropriate work practices for performing the asbestos removal job; medical surveillance program requirements; and a review of 29 CFR 1926.59 safety and health precautions and the use and requirements for protective clothing and equipment including respirators. Fully cover engineering and other hazard control techniques and procedures. Maintain complete and accurate records

of training for each employee. Records shall be maintained for one year beyond the last date of employment.

1.11 Accreditation of Asbestos Removal Personnel

- a. In order to qualify for initial accreditation as an asbestos project supervisor, a person shall meet the following requirements:
 - (1) Have a minimum of six (6) months experience as an asbestos project supervisor or as an asbestos worker.
 - (2) Have attend an approved training course for asbestos project supervision and received a passing score on the written examination for such course during the twelve (12) months prior to submitting an application.
- b. In order to qualify for initial accreditation as an asbestos worker, a person shall have attended an approved training course for asbestos workers or an approved training course for asbestos project supervisors and received a passing score on the written examination for such course during the twelve (12) months prior to submitting an application.

1.12 PERMITS

Obtain necessary permits in conjunction with this project for the transportation and disposition of asbestos containing materials and provide timely notification of such actions as may be required by Federal, State, regional, and local authorities.

1.13 SAFETY AND HEALTH COMPLIANCE

In addition to detailed requirements of this specifications, comply with laws, ordinances, rules, and regulations of Federal, State, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1910.1001, 29 CFR 1926.1101, and 40 CFR 61, Subpart A and 40 CFR 61, Subpart M. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting work. Where specification requirements and referenced documents vary, the most stringent requirement shall apply.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIAL USED IN REMOVAL OPERATIONS

Furnish the Contracting Officer Representative with two complete sets of personal protective equipment, as required herein, for each entry into and inspection of the regulated area.

2.2 RESPIRATORS

Select respirators approved by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing asbestos fibers. Provide personnel engaged in the removal or demolition of pipes, structures, or equipment covered or insulated with asbestos, or in the removal or demolition of asbestos insulation or covering, with [(Type C supplied air respirators) or (half face elastomeric respirators with P-100 Cartridges)]. During the performance of work when removal or demolition of

asbestos materials is not underway and after the TWA and ceiling limit has been established, the Contractor shall provide respirators as required in 29 CFR 1926.1101(h)

RESPIRATOR PROTECTION FOR ASBESTOS FIBERS

Airborne concentration of asbestos or condition of use	Required respirator
Not in excess of 1 f/cc (10XPEL), or otherwise as required independent of exposure	Half-mask air purifying respirator other than a disposable respirator, equipped with high efficiency filters.
Not in excess of 5 f/cc (50XPEL).	Full facepiece air-purifying respirator equipped with high efficiency filters.
Not in excess of 10 f/cc (100XPEL).	Any powered air-purifying respirator equipped with high efficiency filters or any supplied air respirator operated in continuous flow.
Not in excess of 100 f/cc (1,000XPEL), or unknown concentration	Full facepiece supplied air respirator operated in pressure demand mode, equipped with an auxiliary positive pressure self-contained breathing apparatus.

*A high efficiency filter means a filter that is at least 99.97 percent efficient against mono-dispersed particles of 0.3 micrometers in diameter or larger.

*Air purifying respirators must be equipped with high-efficiency particulate air (HEPA) filters. The HEPA filters are not reusable.

(3) Respirator program. Establish a respirator program as required by ANSI Z88.2-80 and 29 CFR 1910.134.

2.3 SPECIAL CLOTHING

2.3.1 Protective Clothing

Protective clothing shall be coveralls or similar whole-body clothing, headcoverings, gloves, and foot coverings.

2.3.2 Work Clothing

Provide cloth work clothes to wear under the protective coveralls and foot covering.

2.4 HYGIENE FACILITIES

A decontamination area shall consist of an equipment room, shower area, and clean room in series. The equipment room shall be supplied with impermeable, labeled bags and containers for the containment and disposal of contaminated protective equipment. Shower facilities shall be provided which comply with 29 CFR 1910.14(d)(3). The clean change room shall be equipped with a locker or appropriate storage container for each employee's use.

2.5 EYE PROTECTION

Provide goggles for personnel engaged in asbestos operations when the use of a full-face respirator is not required.

2.6 WARNING SIGNS AND LABELS

2.6.1 Warning Signs

Warning signs must be of sufficient size to be clearly legible and display the following information:

DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY

RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

2.6.2 Warning Labels

Labels must be of sufficient size to be clearly legible, printed in large, bold letters on a contrasting background, and displaying the following legend:

DANGER

CONTAINS ASBESTOS FIBERS

AVOID CREATING DUST

CANCER AND LUNG DISEASE HAZARD

2.7 LOCAL EXHAUST SYSTEM

Provide a local exhaust system in the enclosed regulated areas. Filters on vacuums and exhaust equipment shall be UL 586-labeled HEPA filters. Local exhaust equipment shall be sufficient to maintain a minimum pressure differential of minus 0.02 inches of water column relative to adjacent, unsealed areas. The local exhaust system must be equipped with a manometer-type negative pressure differential monitor with minor scale division of 0.02 inch of water and accuracy within plus or minus

1.0 percent. The manometer must be calibrated daily as recommended by the manufacturer. Provide manually recorded manometer readings of the pressure differential between the enclosed regulated area and adjacent unsealed areas at the beginning of each workday and every 2 working hours thereafter. The local exhaust system shall be operated continuously, 24 hours per day, until the regulated area enclosure is removed. Replace filters as required to maintain the efficiency of the system. The building heating, ventilating, and air-conditioning (HVAC) system shall not be used as the local exhaust system for the enclosed regulated area.

2.8 TOOLS AND MISCELLANEOUS EQUIPMENT

2.8.1 Airless Sprayer

An airless sprayer, suitable for application of sealing material, shall be used.

2.8.2 Scaffolding

Scaffolding, as required to accomplish the specified work, shall meet all applicable safety regulations.

2.8.3 Transportation Equipment

Transportation equipment, as required, shall be suitable for loading, temporary storage, transporting, and unloading of contaminated waste without exposure to persons or property.

2.8.4 Vacuum Equipment

All vacuum equipment utilized in the work area shall utilize HEPA filtration systems.

2.8.5 Water Sprayer

The water sprayer shall be an airless or other low-pressure sprayer for amended water application.

2.8.6 Other Tools and Equipment

The Contractor shall provide other suitable tools for the stripping, removal, encapsulation and disposal activities including but not limited to knives, stiff nylon brushes, sponges, rounded edge shovels, brooms, and carts.

2.9 MATERIALS

2.9.1 Lockdown Sealant

The sealing agent shall be penetrating sealants and shall meet the following criteria:

- a. They shall withstand most impact or abrasion and protect the surface.
- b. Sealants selected for use by the Contractor shall be one of those demonstrating probable effective performance under the tests conducted by an independent testing laboratory and are approved by the Contracting Officer Representative.

- c. They shall have high flame retardant characteristics, and a low toxic fume and smoke emission rating.
- d. They shall not be noxious or toxic to application workers, or subsequent workers in the area.
- e. They shall have some permeability to water vapor to prevent condensation accumulation, and resist solution by common cleaning agents. They shall be water insoluble when cured.
- f. They shall be acceptable weathering and aging characteristics.
- g. They shall be acceptable by architectural standards.
- h. They shall be compatible with all insulating material likely to be applied to the stripped surfaces.
- i. They shall be demonstrably capable of adhering to the surfaces of the substrate.
- j. They must contain a light blue or red paint tint. (Food coloring is not acceptable.)

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Respirator Program.

Establish a respirator program as required by ANSI Z88.2 and 20 CFR 1910.134.

3.1.2 Protective Clothing

Provide and require the use of protective clothing for any employee entering or performing work inside of the asbestos control area.

3.1.3 Hygiene Facilities

For employees performing Class I work involving over 25 linear or 10 square feet of TSI or surfacing ACM and PACM, establish a decontamination area that consists of an equipment room, shower area, and clean room in series. Ensure that employees enter and exit the regulated area through the Decontamination area. Where it is demonstrated that it is not feasible to locate the shower between the equipment room and the clean room, or where work is performed outdoors, ensure that employees remove asbestos contamination from their work suits in the equipment room using a HEPA vacuum before proceeding to a shower.

For employees performing Class I work involving less than 25 linear or 10 square feet of TSI or surfacing ACM and PACM, and for Class II and Class III work where exposures exceed a PEL, establish a equipment room or area that is adjacent to the regulated area which is covered by a impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size as to accommodate cleaning of equipment and removing personal protective equipment. Ensure that employees enter and exit the regulated area through the equipment room or area.

3.1.4 Warning Signs and Labels

Provide warning signs at approaches to regulated areas containing airborne asbestos fibers. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

3.1.5 Accessibility of Work Areas

The Government will rearrange areas to the extent of providing a reasonable, direct, and unobstructed path to the work sites. During asbestos removal, the Contractor shall confine his equipment and employee pattern to these designated areas. Where the building is still occupied during the removal operations, interference with the functional operation of the building occupants outside these areas will not be permitted. Where conflicts arise due to Contractor's operations, the decision of the Contracting Officer Representative or his authorized representative shall be final.

3.1.6 Preparation for Removal

3.1.6.1 Movable Furnishings

Some movable furnishings, equipment and fixtures in the work area will be pre-cleaned and removed from the area of work by the Government before asbestos work begins. Contractor to remove any remaining items prior to start of asbestos work.

3.1.6.2 Pre-Cleaning

All wall and floor surface areas, other than those from which surface areas, other than those from which asbestos is to be removed, and all non-movable asbestos is to be removed, and all non-movable furnishings, equipment, and fixtures remaining in the work area shall be pre-cleaned with a HEPA filter equipped vacuuming device or wet cleaning methods prior to sealing with plastic sheeting. Do not use any methods which would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. After pre-cleaning, enclose fixed objects in 6-mil polyethylene sheeting, label, and seal securely with tape. Objects which must remain in the work area and that require special ventilation or enclosure requirements shall be suitably protected as approved by the Contracting Officer Representative. Items in the work area which may require access by User during abatement shall be designated during the pre-abatement walkthrough and enclosures constructed with access flops sealed with waterproof tape.

3.1.7 Regulated Areas

All Class I, II, and III asbestos work shall be conducted within regulated areas. The regulated area shall be demarcated in any manner that minimizes the number of persons within the area and protects persons outside the area from exposure to airborne concentrations of asbestos. Where critical barriers or negative pressure enclosures are used, demarcate the regulated area. Signs shall be provided and displayed pursuant to 29 CFR 1026.1101(k)(6). Access to regulated areas shall be limited to authorized persons. All persons entering a regulated area where employees are required to wear respirators, shall be supplied with a respirator. All personnel wearing a respirator shall be medically cleared and fit tested. All asbestos work performed within regulated areas shall be supervised by a competent person.

3.1.7.1 Non-Enclosed Regulated Area Requirements

The construction of an enclosed regulated area is impractical for removal activities. Provide a 20-foot roped off perimeter around the area where asbestos handling procedures are performed and maintain other requirements for regulated areas. Also, where an enclosure is not provided, conduct personal and area monitoring of airborne fibers during the work shift at the designated limits downwind of the asbestos work area at not less than once every 4 hours. If the concentration of airborne asbestos fibers monitored at the designated limits at any time exceeds the lesser of two times the background or the action level, evacuate personnel in adjacent areas. If adjacent areas are contaminated, clean the contaminated areas, monitor, and visually inspect the area as specified herein.

3.2 ASBESTOS ABATEMENT PROCEDURES

3.2.1 Initial Exposure Assessment

Ensure that a "competent person" conducts an exposure assessment immediately before or at the initiation of the operation to ascertain expected exposures during that operation or workplace. The assessment must be completed in time to comply with requirements which are triggered by exposure data or the lack of a "negative exposure assessment," and to provide information necessary to assure that all control systems planned are appropriate for that operation and will work properly.

An Initial Exposure Assessment shall be conducted in accordance with 29 CFR 1926.1101

For Class I asbestos work, until exposure monitoring is conducted, and is documented that employee on the job will not be exposed in excess of the PELs, or otherwise makes a negative exposure assessment, it is presumed that employees are exposed in excess of the TWA and excursion limit. A negative exposure assessment can only be obtained by demonstrating requirements contained in 29 CFR 1926.1101.

3.2.2 Monitoring Requirements

Perform exposure monitoring as required to determine accurately the airborne concentrations of asbestos to which employees are exposed. Determinations of employee exposure shall be made from breathing zone air samples that are representative of the 8-hour TWA and 30-minute short-term exposures of each employee. Representative 8-hour TWA employee exposure shall be determined on the basis of one or more samples representing full-shift exposure for employees in each work area. Representative 30-minute short-term employee exposures shall be determined on the basis of one or more samples representing 30 minute exposures associated with operations that are most likely to produce exposures above the excursion limit for employees in each work area.

3.2.2.1 Background Monitoring Prior to Asbestos Work

Provide area monitoring and establish the reference TWA 1 day prior to the masking and sealing operations for each asbestos removal site. The reference TWA is determined by taking at least three general area air samples in each asbestos regulated area.

3.2.2.2 Periodic monitoring

Conduct daily monitoring that is representative of the exposure of each employee who is assigned to work within a regulated area who is performing Class I or II work unless a negative exposure assessment for the entire operation has been made. Conduct periodic monitoring of all work where

exposures are expected to exceed a PEL at intervals sufficient to document the validity of the exposure prediction. When all employees required to be monitored daily are equipped with supplied-air respirators operated in the positive-pressure mode, daily monitoring is not required. However, employees performing Class I work using a control method which is not listed in Class I Requirements paragraph, shall continue to be monitored daily even if they are equipped with supplied-air respirators.

3.2.2.3 Monitoring Adjacent Areas Prior to Asbestos Work

Provide area monitoring and establish the reference TWA inside the building outside the enclosed regulated area 1 day prior to beginning asbestos work.

3.2.2.4 Termination of Monitoring

If the periodic monitoring reveals that employee exposures, as indicated by statistically reliable measurement, are below the PEL and excursion limit, monitoring may be discontinued for those employees whose exposures are represented by such monitoring. Institute additional monitoring whenever there has been a change in process, control equipment, personnel or work practices that may result in new or additional exposures above the PEL and/or excursion limit.

3.2.3 Respiratory Protection

Respirators shall be used during all Class I work, during all Class II work where the ACM is not removed in a substantially intact state, during all Class II and III work which is not performed using wet methods, during all Class II and III work where a negative exposure assessment is not produced, and during all Class III jobs where TSI or surfacing ACM or PACM is being disturbed. Provide the appropriate respirator as specified.

3.2.4 Controls and Work Practices

The following controls and work practices shall be used in all classes of work regardless of levels of exposure:

- a. Vacuum cleaners equipped with HEPA filters to collect all debris and dust containing ACM or PACM
- b. Wet methods, or wetting agents, to control employee exposures during asbestos shandling, mixing, removal, cutting, application, and cleanup, except where demonstrated that the use of wet methods are infeasible
- c. Prompt clean-up and disposal of wastes and debris contaminated with asbestos in leak-tight container
- d. Local exhaust ventilation equipped with HEPA filter dust collection systems
- e. Enclosure or isolation of processes producing asbestos dust
- f. Ventilation of the regulated area to move contaminated air away from the breathing zone and toward a filtration or collection device equipped with a HEPA filter

The following work practices and controls shall not be used for work related to asbestos or the work which disturbs ACM or PACM, regardless of measured levels of asbestos exposure or results of the initial exposure assessments:

- a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filters exhaust air;
- b. Compressed air used to remove asbestos, or ACM, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air;
- c. Dry sweeping, shoveling or other dry clean-up and debris containing ACM and PACM;
- d. Employee rotation as a means of reducing employee exposure to asbestos.

3.2.5 Class I Abatement Requirements

In addition to all provisions required in control and work methods above, the following controls and work practices shall be used for all Class I work.

- a. Installation and operation of the control systems, shall be supervised by a competent person.
- b. Work involving the removal of more than 25 linear or 10 square feet of thermal system insulation or surfacing material; for all other Class I jobs, where a negative exposure assessment, or where employees are working in areas adjacent to the regulated area, while the Class I work is being performed, use one of the following methods to ensure that airborne asbestos does not migrate from the regulated areas:
 - (1) Critical barriers shall be placed over all openings to the regulated area;
 - (2) Use another barrier or isolation method which prevents the migration of airborne asbestos from the regulated area, as verified by perimeter area surveillance during each work shift at each boundary of the regulated area, showing no visible asbestos dust; and perimeter area monitoring showing that clearance levels contained in 40 CFR Part 763, Subpt. 3, or that perimeter area levels are no more than background levels representing the same area before the asbestos work began.
- c. HVAC systems shall be isolated in the regulated area by sealing with a double layer of 6 mil plastic or the equivalent;
- d. Impermeable drop cloths shall be placed on surfaces beneath all removal activity;
- e. All objects within the regulated area shall be covered with impermeable drop cloths or plastic sheeting which is secured by duct tape or an equivalent.
- f. Where a negative exposure assessment cannot be produced, or where exposure monitoring shows that a PEL is exceeded, ventilate the regulated area to move contaminated air away from the breathing zone of employees toward a HEPA filtration or collection device.

3.2.5.1 Negative Pressure Enclosure (NPE) Systems

A Negative Pressure Enclosure (NPE) System shall be used where the configuration of the work area does not make the erection of the enclosure infeasible. Specifications and work practices shall be as required in 29 CFR 1926.1101(g)(5).

3.2.5.2 Glovebag Systems

Glovebag systems shall be used to remove PACM and/or ACM from straight runs of piping with the following specifications and work practices. Each glovebag shall be installed so that it completely covers the circumference of pipe or other structure where the work is to be done. Shall be smoke- tested for leaks and any leaks sealed prior to use and may be used only once and may not be moved. Shall not be used on surfaces whose temperature exceeds 150 degrees. Prior to disposal, they shall be collapsed by removing air within them using a HEPA vacuum. Before beginning the operation, loose and friable material adjacent to the glovebag/box operation shall be wrapped and sealed in two layers of six mil plastic or otherwise rendered intact.

Where system uses attached waste bag, such bag shall be connected to collection bag using hose or other material which shall withstand pressure of ACM waste and water without losing its integrity. Sliding valve or other device shall separate waste bag from hose to ensure no exposure when waste bag is disconnected.

At least two persons shall be required to perform Class I glovebag removals.

3.2.5.3 Negative Pressure Glove Bag Systems

A Negative Pressure Glove Bag System shall be used to remove ACM or PACM from piping. Attach HEPA vacuum systems or other devices to bag to prevent collapse during removal and run continually during the operation. Where a separate waste bag is used along with a collection bag and discarded after one use, the collection bag may be reused if rinsed clean with amended water before reuse.

3.2.5.4 Negative Pressure Glove Box Systems

A Negative Pressure Glove Box System shall be used to remove ACM or PACM from pipe runs. Box shall be constructed with rigid sides and made from metal or other material which can withstand the weight of the ACM and PACM and water used during removal. A negative pressure generator shall be used to create negative pressure in system. An air filtration unit shall be attached to the box. The box shall be fitted with gloved apertures. An aperture at the base of the box shall serve as a bagging outlet for waste ACM and water. A back-up generator shall be present on site. The box shall be smoke tested prior to each use. At least two persons shall perform the removal.

3.2.5.5 Water Spray Process System

A Water spray Process System shall be used for removal of ACM and PACM from cold line piping if, employees carrying out such process have completed a 40-hour separate training course in its use, in addition to training required for employees performing Class I work. Piping shall be surrounded on 3 sides by rigid framing. A 360 degree water spray, delivered through nozzles supplied by a high pressure separate water line, shall be formed around the piping. The system shall be operated by at least three persons, one of whom shall not perform removal, but shall check equipment, and ensure proper operation of the system. After removal, the ACM and PACM shall be bagged while still inside the water barrier.

3.2.5.6 Intact Asbestos Insulated Pipe Removal

When both piping and insulation are to be removed intact, wet the insulation, then, using glovebag technique, remove 10-inch to 12-inch section of the pipe insulation and encapsulate exposed edges of the asbestos insulation to remain, remove the glovebag, cut and remove the intact insulated pipe. Long components removed intact may be wrapped in 2 layers or 6-mil polyethylene sheeting secured with tape at the ends, prior to or after cutting the pipe, for transport to the landfill. Intact insulated pipe shall be removed in manageable sections.

3.2.6 Class II Abatement Requirements

Class II asbestos work shall be performed by complying with work practices and controls designated for each type of asbestos work to be performed set out in 29 CFR 1926.1101((g)(7)). Class II work also may be performed using a method allowed for Class I work, except that glove bags and glove boxes are allowed if they fully enclose the Class II material to be removed.

3.2.6.1 Vinyl and Asphalt Flooring Materials

- a. The material (floor tile and black mastic) shall be thoroughly wetted with amended water prior to and during its removal.
- b. The material shall be removed in an intact state unless the employer demonstrates that intact removal is not possible. When tiles are heated and can be removed intact, wetting may be omitted.
- c. Cutting, abrading, or breaking the material shall be prohibited unless the employer can demonstrate that methods less likely to result in asbestos fiber release are not feasible.
- d. ACM removed shall be immediately bagged or wrapped, or kept wetted until transferred to a closed receptacle, no later than the end of the work shift.
- e. Flooring or its backing shall not be sanded.
- f. Vacuums equipped with HEPA filter, disposable dust bag, and metal floor tool (no brush) shall be used to clean floors.
- g. All scraping of residual adhesive and/or backing shall be performed using wet methods.
- h. Dry sweeping is prohibited.
- i. Mechanical chipping is prohibited unless performed in a negative pressure enclosure which meets the requirement of this section.

3.2.6.2 Roofing Material Removal

- a. Roofing material shall be removed in an intact state to the extent feasible.
- b. Wet methods shall be used where feasible.

- c. Cutting machines shall be continuously misted during use, unless a competent person determines that misting substantially decreases worker safety.
- d. All loose dust left by the sawing operation must be HEPA vacuumed immediately.
- e. Unwrapped or unbagged roofing material shall be immediately lowered to the ground via covered dust-tight chute, crane, or hoist, or placed in an impermeable waste bag or wrapped in plastic sheeting and lowered to ground no later than the end of the work shift.
- f. Upon being lowered, unwrapped material shall be transferred to a closed receptacle in such manner so as to preclude the dispersion of dust.
- g. Roof level heating and ventilation air intake sources shall be isolated or the ventilation system shall be shut off.

3.2.6.3 Cementitious Asbestos-Containing Siding and Shingles or Transite Panels

- a. Cutting, abrading or breaking siding, shingles, or transite panels, shall be prohibited unless the employer can demonstrate that methods less likely to result in asbestos fiber release cannot be used.
- b. Each panel or shingle shall be sprayed with amended water prior to removal.
- c. Unwrapped or unbagged panels or shingles shall be immediately lowered to the ground via covered dust-tight chute, crane or hoist, or placed in an impervious waste bag or wrapped in plastic sheeting and lowered to the ground no later than the end of the work shift.
- d. Nails shall be cut with flat, sharp instruments.

3.2.6.4 Gaskets Containing ACM

- a. If visibly deteriorated and unlikely to be removed intact, removal shall be undertaken within a glovebag.
- b. The gasket shall be thoroughly wetted with amended water prior to its removal.
- c. The wet gasket shall be immediately placed in a disposal container.
- d. Any scraping to remove residue must be performed wet.

3.2.6.5 Transite Board Removal Method

The wallboard material shall be sprayed with a lockdown sealant in order to reduce the potential of fiber release and the fasteners and board shall be removed. After removal, the wallboard shall be wrapped in two layers of 6-mil plastic and sealed with tape. If the size of the wallboard permits, the wrapped material shall be placed in drums for disposal. The wallboard shall not be sawed, crushed or abraded at any time during removal. Clean up shall consist of HEPA vacuuming any accumulated asbestos debris and spraying of lockdown sealant on the framing to which the wallboard material was fastened.

3.2.6.6 Trowelled-On Wall Plaster Removal Method

The material is sprayed with amended water and saturated sufficiently to wet it to the substrate without causing excess dripping. Remove the saturated material in small sections. The asbestos material is sprayed repeatedly during the work process to maintain wet conditions and to minimize asbestos fiber dispersion. As it is removed, the material is placed in 6-mil plastic bags and appropriate containers for disposal.

3.2.6.7 Black Mastic on Roof Drain Piping Removal

- a. The material shall be thoroughly wetted with amended water prior and during its removal.
- b. Two layers of ground cover shall be applied under the piping during abatement.
- c. The pipe shall be removed in an intact state unless the employer demonstrates that intact removal is not possible.
- d. Vacuums equipped HEPA filter shall be used to clean the area surrounding the pipe.
- e. Cutting, abrading, or breaking the material shall be prohibited unless the employer can demonstrate that methods less likely to result in asbestos fiber release are not feasible.
- f. ACM removed shall be immediately bagged or wrapped, or kept wetted until transfer to a closed receptacle, no later than the end of the work shift.

3.2.6.8 Fire Door and Chalkboard Removal

1. The material shall be thoroughly wetted with amended water prior and during its removal.
2. The materials shall be removed in an intact state.
3. ACM removed shall be immediately bagged or wrapped, or kept wetted until transferred to a closed receptacle, no later than the end of the work shift.

3.2.6.9 Any other Class II Removal of ACM

- a. The material shall be thoroughly wetted with amended water prior and during its removal.
- b. The material shall be removed in an intact state unless the employer demonstrates that intact removal is not possible.
- c. Cutting, abrading, or breaking the material shall be prohibited unless the employer can demonstrate that methods less likely to result in asbestos fiber release are not feasible.
- d. ACM removed shall be immediately bagged or wrapped or kept wetted until. transferred to a closed receptacle, no later than the end of the work shift.

3.2.7 Class III Asbestos Work

Class III work shall be performed using wet methods. To the extent feasible, work shall be performed using local exhaust ventilation. Where disturbance involves drilling, cutting, etc., use impermeable drop cloths, and shall isolate the operation using mini-enclosures or glovebag systems. Work which involves the disturbance of TSI require respirators.

3.3 COLLECTION

3.3.1 Nonfriable Non-Regulated Asbestos Containing Material (Non-RACM)

The following types of non-friable ACM that may be found in this project are considered non-RACM and do not require special collection action:

Vinyl Asbestos Flooring
Asphalt Roofing

All notification requirements are still applicable, however, to non-RACM.

3.3.2 Regulated Asbestos Containing Material (RACM)

Asbestos containing material shall be removed in manageable sections. Removed material should be containerized before moving to a new location for continuance of work. Surrounding areas within the 20-foot perimeter shall be periodically sprayed and maintained in a wet condition until visible material is cleaned up.

Maintain surfaces of the regulated area free of accumulations of asbestos fibers. Restrict the spread of dust and debris; keep waste from being distributed over the general area. Do not dry sweep or blow down the space with compressed air. Clean all surfaces in the work area and other contaminated areas with water. When asbestos removal, disposal, and cleanup are complete, the Contractor shall certify, in writing, that the concentration of airborne fibers in the regulated area is less than 0.01 fibers (longer than 5 micrometers) per cubic centimeters of air. Do not remove the regulated area enclosure or roped-off perimeter and caution signs prior to the Contracting Officer Representative's receipt of the certification. After final cleanup, remove filters on the building HVAC system and provide new filters. Dispose of filters as asbestos-contaminated waste. Reestablish HVAC, mechanical, and electrical systems in proper working order. The Contracting Officer Representative will visually inspect the affected surfaces for residual asbestos material and accumulated dust; the Contractor shall reclean areas showing dust or residual asbestos materials. If recleaning is required, monitor the airborne fiber concentration after recleaning. Notify the Contracting Officer Representative before unrestricted entry is permitted. The Government shall have the option to perform independent monitoring to certify the areas are safe before entry is permitted.

Collect asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing which may produce airborne concentrations of asbestos fibers; place in sealed impermeable bags imprinted with a caution label and shall also be labeled with the name of the Contractor and the location at which the waste was generated. Place bags in disposable asbestos-waste drums. Steel drums are not allowed.

Label wrapped materials that will not fit in drums in the same manner as described in para. 1. above.

3.3.2.1 Removing Material Intact

Asbestos containing material removed from the building shall not be dropped or thrown to the ground. Material should be removed as intact sections whenever possible and carefully lowered to the ground. Materials between 15 and 50 feet above the ground may be containerized at elevated levels or placed into inclined chutes or scaffolding for subsequent collection and containerization. Asbestos materials in open containers shall be kept wet at all times.

3.3.2.2 Containers

Containers (drums or 6-mil polyethylene bags) shall be sealed when full. Wet material will be heavy and double bagging of waste material is usually necessary. A determination of need for single or double bags must be made early in the abatement process and approved by the Contracting Officer Representative. Bags, if used, shall not be overfilled. They should be securely sealed to prevent accidental opening and leakage by tying tops of bags in an overhand knot or by taping in gooseneck fashion. Do not seal bags with wire or cord. Bags may be placed in drums for staging and transportation to the landfill. Bags shall be decontaminated on exterior surfaces by wet cleaning before being placed in clean drums and sealed with locking ring tops. Where unusual circumstances prohibit use of plastic disposal bags or drums, the Contractor shall submit, in the asbestos plan, an alternate proposal for removal, containerizing, and disposal of the asbestos materials and fibers.

3.3.2.3 Sharp-Edged Components

Asbestos containing or contaminated waste with sharp edged components (e.g., nails, screws, metal lath, tin sheeting) that could otherwise tear polyethylene bags shall be placed into drums for disposal.

3.3.2.4 Asbestos Contaminated Soil

The removed soil shall be placed in 6-mil plastic bags, sealed and then placed in asbestos waste drums for disposal. Do not overfill plastic bags.

3.3.2.5 Wastewater

- a. Pre-filtering. Any water produced by the decontamination of either equipment or persons shall be (1) collected, (2) filtered through a system capable of trapping particles 5 microns and larger, specifically designed to remove asbestos fibers, and (3) drummed for offsite disposal or filtrate disposed into a local sanitary sewer system.
- b. Filter System. The filtration system shall contain a series of several filters with progressively smaller pore sizes to avoid rapid clogging of the system by large particles. Disposable filters shall be treated as asbestos waste.

3.4 DISPOSAL OF ACM

3.4.1 Nonfriable Non-Regulated Asbestos Containing Material (Non-RACM)

The following types of non-friable ACM that may be found in this project are considered non-RACM and do not require special disposal action:

Vinyl Asbestos Flooring
Asphalt Roofing

All notification requirements are still applicable, however, to non-RACM.

3.4.2 Regulated Asbestos Containing Material (RACM)

The contractor to whom this section applies shall comply with the following procedures:

1. Mix asbestos-containing waste from control devices with water to form a slurry; adequately wet other asbestos-containing waste material; and
2. After wetting, seal all asbestos-containing waste material in leak-tight containers while wet; and IV. Label the containers as follows: CAUTION! CONTAINS ASBESTOS - AVOID OPENING OR BREAKING CONTAINER. BREATHING ASBESTOS IS HAZARDOUS TO YOUR HEALTH.
3. Discharge no visible emissions to the outside air during the collection, processing, packaging, transporting or deposition of any asbestos-containing waste material.
4. Once drums, bags and otherwise containerized asbestos containing materials have been removed from the work area, they shall be loaded into an enclosed truck for transportation to the designated landfill. Asbestos waste shall not be allowed to be placed in trucks with non-asbestos waste.
5. The enclosed cargo area of the truck shall be free of debris and lined with 6-mil polyethylene sheeting to prevent contamination from leaking or spilled containers. Floor sheeting shall be installed first and extend up the sidewalls. Wall sheeting shall be overlapped and taped into place so that no materials may escape to the environment.
6. Drums shall be placed on level surfaces in the cargo area and packed tightly together to prevent shifting and tipping. Do not throw containers into the cargo area.
7. Personnel loading asbestos containing waste shall be protected by disposable clothing including head, body and foot protection and at a minimum, half-face piece, air purifying, dual cartridge respirators equipped with high efficiently particulate air (HEPA) filters.
8. Large steel dumpsters (roll-off type) may be used for asbestos waste disposal. These should be lined with polyethylene and should have doors, tops, or covers that can be closed to prevent vandalism or other disturbance of the containerized asbestos debris and wind dispersion of asbestos fibers. Uncontainerized asbestos materials shall not be placed in these type dumpsters, nor shall they be used for non-asbestos waste. Bags shall be placed, not thrown, into these containers to avoid splitting.
9. Dispose of waste asbestos material at NC DEP-permitted sanitary landfill off Government property.
10. For temporary storage, store sealed impermeable bags in asbestos waste drums. An area for interim storage of asbestos waste-containing drums will be assigned by the Contracting Officer Representative or by an authorized representative. This area must be secure. No ACM wastes, except those properly labeled and properly containerized and physically located in the assigned holding area shall be allowed to remain at the site overnight.
11. Procedure for hauling and disposal shall comply with 40 CFR 61, Subpart M, 40 CFR 241, 40 CFR 257, and State, regional and local standards. Vehicles used to transport asbestos-containing waste material must be marked as follows:

Mark vehicles used to transport asbestos-containing waste material during the loading and unloading of the waste so that the signs are visible. The markings must:

- (i) Be displayed in such a manner and location that a person can easily read the legend.
- (ii) Conform to the requirements for 51 cm x 36 cm (20 in. x 14 in.) upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and
- (iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend

DANGER
ASBESTOS DUST HAZARD
CANCER AND LUNG DISEASE HAZARD
Authorized Personnel Only

Notation

2.5 cm (1 inch) Sans Serif, Gothic or Block
2.5 cm (1 inch) Sans Serif, Gothic or Block

1.9 cm (3/4 inch) Sans Serif, Gothic or Block 14 Point Gothic

Spacing between any two lines must be at least equal to the height of the upper of the two lines.

12. Upon reaching the landfill, trucks are to approach the dump location as closely as possible for unloading of the asbestos containing waste.

13. Bags, drums, and components shall be inspected as they are offloaded at the disposal site. Material in damaged containers shall be repacked in empty drums or bags as necessary.

14. Waste containers shall be placed on the ground at the disposal site, not pushed or thrown out of trucks since the weight of wet material could rupture containers.

15. Personnel off-loading containers at the disposal site shall wear protective equipment consisting of disposable head, body, and foot protection and, at a minimum, half-face piece, air-purifying, dual cartridge respirators equipped with high efficiency particulate air (HEPA) filters. Following the removal of all containerized waste, the truck cargo area shall be decontaminated to meet the no visible residue criteria. Polyethylene sheeting shall be removed and discarded along with contaminated cleaning materials and protective clothing, in bags or drums at the disposal site. If landfill personnel have not been provided with personal protective equipment for the compaction operation by the landfill operator, Contractor shall supply protective clothing and respiratory protection for the duration of this operation.

16. Shipment Records

- a. Maintain waste shipment records, using a form similar to that shown at the end of this section and include the following information:
 - (i) The name, address, and telephone number of the waste generator.

- (ii) The name and address of the local, State, or EPA Regional office responsible for administering the asbestos NESHAP program.
 - (iii) The approximate quantity in cubic meters (cubic yards).
 - (iv) The name and telephone number of the disposal site operator.
 - (v) The name and physical site location of the disposal site.
 - (vi) The date transported.
 - (vii) The name, address, and telephone number of the transporter(s).
 - (viii) A certification that the contents of this consignment are fully and accurately described by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and government regulations.
- b. Provide a copy of the waste shipment record, described above to the disposal site owners or operators at the same time as the asbestos-containing waste material is delivered to the disposal site.
- c. For waste shipments where a copy of the waste shipment record, signed by the owner or operator of the designated disposal site, is not received by the Contractor within 35 days of the date the waste was transported, contact the owner or operator of the designated disposal site to determine the status of the waste shipment. The Contractor shall report in writing to the NESHAP-administering agency if a copy of the waste shipment record, signed by the owner or operator of the designated waste disposal site, is not received by the Contractor within 45 days of the date the waste was transported. Include in the report the following information:
- (i) A copy of the waste shipment record for which a confirmation of delivery was not received, and
 - (ii) A cover letter explaining the efforts taken to locate the asbestos waste shipment and the results of those efforts.
- d. Retain a copy of all waste shipment records, including a copy of the waste shipment record signed by the owner or operator of the designated waste disposal site, for at least 2 years.
- e. Provide to the Contracting Officer Representative within 3 working days following delivery of asbestos containing waste material (ACWM), copies of all waste shipment record. Also, within 3 working days of initiation, provide to the Contracting Officer Representative copies of any correspondence with the NESHAP-administering agency.

Furnish upon request, and make available for inspection by the NESHAP-administering agency, all records under this section.

3.4.3 Wastewater

It is the Contractor's responsibility to comply with any local wastewater systems' regulations or policy

regarding the disposal of wastewater from asbestos abatement activities.

3.5 CLEANUP AND FINAL CLEARANCE

3.5.1 Visual Inspection After Cleanup

Prior to the performance of final air monitoring, the Contractor and the Contracting Officer Representative or his representative shall perform a visual inspection for asbestos dust/residue. If residue is found, additional wipe down/vacuuming shall be performed to satisfaction of the Contracting Officer Representative.

3.5.2 Monitoring After Final Cleanup

After the removal site has passed the visual inspection, provide area monitoring of fibers (at least 3 samples per removal site) under aggressive conditions and establish the TWA of less than 0.01 fibers (Longer than 5 micrometers) per cubic centimeter of air after final cleanup but before removal of the enclosure of the regulated area. Provide area monitoring and establish the TWA 2 days and 5 days after the enclosure of the regulated area is removed. Provide area monitoring and establish the TWA after final cleanup when an enclosure is not required. The fiber counts from the samples shall be less than 0.01 fibers (longer than 5 micrometers) per cubic centimeter of air or be not greater than the reference TWA, whichever is less. Should any of the final samplings indicate a higher value, the Contractor shall take appropriate actions to reclean the area and shall repeat the monitoring.

3.5.3 Air Sampling

Air Sampling under aggressive conditions shall include the following procedures:

- a. Before starting the sampling pumps, direct the exhaust from forced air equipment (such as 1 horsepower leaf blower) against all walls, ceiling, floors, ledges and other surfaces in the room. This should take at least 5 minutes per 1000 sq. ft. of floor.
- b. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.
- c. Start the sampling pumps and sample for the required time.
- d. Turn off the pump and then the fan(s) when sampling is complete.

3.5.4 Air Clearance Failure

Should clearance sampling results fail to meet the final cleanup requirements, the Contractor shall take appropriate action at no additional cost to the Government, to reclean, resample, and analyze data until final cleanup requirements are met.

3.5.5 Site Inspection

While performing asbestos removal work, the Contractor shall be subject to onsite inspection by the Contracting Officer Representative who may be assisted by safety or health personnel. If the work is in violation of specification requirements, the Contracting Officer Representative will issue a stop work

order to be in effect immediately and until the violation is resolved. Standby time and expenses required to resolve the violation shall be at the Contractor's expense.

3.5.6 Sealing Permanent Exposed Surfaces (RACM)

After the asbestos material has been removed and HEPA vacuumed to the greatest extent possible, all permanent asbestos exposed interior surfaces shall be coated with an approved lockdown sealant to permanently bind any remaining fibers in place. Sealant shall be applied by airless sprayers and in accordance with the sealant manufacturers recommendations.

3.5.7 Sealant Tint

The sealant shall have an adequate tint to easily distinguish between sections sealed and sections not sealed.

3.5.8 Reestablishment of the Work Area

Reestablishment of the work area shall only occur following the completion of clean-up procedures and after clearance air monitoring has been performed and documented to the satisfaction of the Contracting Officer Representative.

3.5.9 Visual Inspection

The Contractor and Contracting Officer Representative shall visually inspect the work area for any remaining visible residue. Evidence of asbestos materials will necessitate additional cleaning requirements.

3.5.10 Clearance of Work Area

Following satisfactory clearance of the work area, remaining barriers may be removed and disposed of as asbestos contaminated waste.

3.5.11 Remaining Building Demolition Procedures

Contractor may proceed with remaining building demolition procedures after complying with the removal and disposal of paint with lead abatement specification, removal and disposal of totally enclosed PCBs abatement specification, and all other federal, state, and local requirements.

END OF SECTION

CERTIFICATE OF WORKER'S RELEASE

DATE: _____

TO: _____
(Insert Owner's Name and Address)

COR: _____
(Insert Project Name and Address)

In consideration of my employment by _____ in
(Contractor)

connection with the removal and disposal of asbestos, or other work in asbestos-contaminated work areas, and in consideration of the sum of ONE AND NO/100 (\$1.00) DOLLAR and other good and valuable consideration in hand paid, at and before the sealing and delivery of these presents, the receipt, sufficiency, and adequacy of which are hereby acknowledged, the undersigned does hereby acknowledge, warrant, represent, covenant, and agree as follows:

1. I acknowledge and understand that I have been or will be employed in connection with the removal of, disposal of, or other treatment to, asbestos, or other work in asbestos-contaminated work areas, and I acknowledge that in handling asbestos and breathing asbestos dust, including, but not limited to, THE FACT THAT ASBESTOS CAN CAUSE ASBESTOSIS AND IS A KNOWN CARCINOGEN, AND CAN THEREFORE CAUSE VARIOUS TYPES OF CANCER.

2. I acknowledge and understand that ANY CONTACT WITH ASBESTOS, WHETHER IT CAN BE SEEN OR NOT, MAY CAUSE ASBESTOSIS AND VARIOUS FORMS OF CANCER, WHICH MAY NOT SHOW UP FOR MANY YEARS, AND I covenant and agree faithfully to take all precautions required of me.

3. I knowingly assume all risks in connection with potential exposure to asbestos and I do hereby release and forever discharge Owner, Architect, independent laboratory or engineers employed by the Owner or Architect, and all of their directors, officers, employees, nominees, personal representatives, affiliates, successors, and assigns from and against any and all liability whatsoever, at common law or otherwise, except any rights which the undersigned may have under the provisions of the applicable Workmen's Compensation Laws. Except as specifically set forth herein, I hereby waive and relinquish any and all claims of every nature which I now have or may have or claim to have which are in any way, directly or indirectly related to exposure of asbestos and asbestos-containing materials.

Name of Worker
(Must be typed)

Signature of Worker
(As acknowledgement of reading this
page of this two-page Certificate.)

CERTIFICATE OF WORKER'S RELEASE, Cont.

4. I hereby warrant and represent that I have not been disabled, laid-off, or compensated in damages or otherwise, because of the disease of asbestosis.

SIGNATURE_____

SOCIAL SECURITY NUMBER_____

SIGNED IN PRESENCE OF:

Notary No. and Seal

(Submit one copy for each employee prior to employee starting work.)

SPECIAL ENDORSEMENT (INSURANCE)

Attached to and forming a part of Policy No. _____ of the
_____ issued at is _____ Agency.
(Name of Insurance Company) (City) (State)

Date of endorsement _____ for

(Name of Project)

In consideration of the premium for which the policy is written and proper rate adjustment when applicable, the insurance company agrees as follows:

The insurance company agrees that this policy shall not be cancelled, changed, allowed to lapse, or expire until 30 days after the Owner has received written notice thereof as evidenced by return receipt of registered letter or until such time as other valid and effective insurance coverage acceptable in every respect to the Owner and providing protection equal to protection called for in the policy shown below shall have been received, accepted, and acknowledged by the Owner.

The insurance company acknowledges and agrees that this policy is applicable for Contractor or Subcontractor whose business is asbestos removal or asbestos abatement.

Any other provisions to the contrary notwithstanding, coverage under this policy shall specifically include all operations of asbestos abatement required by the project named above.

The forgoing insurance provisions have been incorporated into the reference and are hereby made a part of Insurance Policy No. _____, this _____ day of _____, 20__.

(Name of Company)

(Signature of Authorized Representative)

EMPLOYEE SAFETY INSTRUCTION FORM

Employee Name: _____

Employee Address: _____

Employee Telephone No.: _____

Union Card Number: _____

Classification of Worker: _____

Have you had in the past, or present, any respiratory problems?

Yes _____ No _____

Have you worked in the past with asbestos or fiberglass type materials?

Yes _____ No _____

The project you will be working on involves the use of asbestos and the removal of the asbestos from the building. Asbestos is considered a health hazard.

The company is supplying all necessary safety clothing and working conditions required and necessary for your protection from asbestos hazard.

You shall be instructed at commencement of the job on the required use of safety equipment, clothing, working conditions and procedures. These must be rigidly adhered to. Smoking is not permitted in the work areas. Disregarding of safety instructions shall result in instant dismissal.

I acknowledge that safety instructions have been given to me by the company at my work commencement and I am thoroughly conversant with them and have answered the above questions truthfully.

Signed _____

Employee

Date _____

(Submit one copy for each employee prior to employee starting work.)

RESPIRATOR TRAINING CERTIFICATION

PROJECT NAME: _____

I hereby certify that I have been trained in the use of each type of respiratory protection equipment required for use on this Project. The training included the following:

1. Explanation of dangers related to misuse.
2. Instruction on putting on, fitting, testing and wearing the respirator.
3. Instruction on inspection, cleaning and maintaining the respirator.
4. Instruction on emergency situations.

I further certify that I understand the use, care and inspection of the respirator and have tested and work the unit.

Signed: _____

Date: _____

Superintendent's Signature: _____

(Submit one copy for each employee prior to employee starting work)

CERTIFICATE OF VISITOR'S RELEASE

DATE: _____

TO: _____
(Insert Project Name and Address)

In consideration of my visit(s) to the above-named project in connection with the removal and disposal of asbestos, or other work in asbestos-contaminated work areas, the undersigned does hereby acknowledge, warrant, represent, covenant, and agree as follows:

1. I acknowledge and understand that I have been or will be employed in connection with the removal of, disposal of, or other treatment to, asbestos, or other work in asbestos contaminated work areas, and I acknowledge that I have been advised of and I understand the dangers inherent in handling asbestos and breathing asbestos dust, including, but not limited to, THE FACT THAT ASBESTOS CAN CAUSE ASBESTOSIS AND IS A KNOWN CARCINOGEN AND CAN, THEREFORE, CAUSE VARIOUS TYPES OF CANCER.
2. I acknowledge and understand that ANY CONTACT WITH ASBESTOS, WHETHER IT CAN BE SEEN OR NOT, MAY CAUSE ASBESTOSIS AND VARIOUS FORMS OR CANCER, WHICH MAY NOT SHOW UP FOR MANY YEARS, and I covenant and agree faithfully to take all precautions required of me.

Signature of Visitor
(as acknowledgement of reading
this page 1 of this two-page
Certificate)

3. I knowingly assume all risks in connection with potential exposure to asbestos and I do hereby, for myself and my heirs at law, release and forever discharge Owner, Owner's Representative, Architect, independent testing laboratory or engineers employed by the Owner, Owner's Representative, Architect, and all of their directors, officers, employees, nominees, personal representatives, affiliates, successor, and assigns from and against any and all liability whatsoever, at common law or otherwise, except any rights the applicable workmen's compensation laws. Except as specifically set forth herein I hereby waive and relinquish any and all claims of every nature which I now have or may have or claim to have which are in any way, directly or indirectly, related to exposure to asbestos and asbestos-containing materials.
4. I hereby warrant and represent that I have not been disabled, laid-off, or compensated in damages or otherwise, because of the disease of asbestosis.

Signature _____

Social Security Number _____

Signed in presence of:

(General Superintendent)

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SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.2 DEFINITIONS

- A. AC: Articulation Class.
- B. CAC: Ceiling Attenuation Class.
- C. LR: Light Reflectance coefficient.
- D. NRC: Noise Reduction Coefficient.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension system members.
 - 2. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 4. Minimum Drawing Scale: 1/8 inch = 1 foot
- C. Samples for Initial Selection: For components with factory-applied color finishes.
- D. Qualification Data: For testing agency.
- E. Field quality-control test reports.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.
- G. Research/Evaluation Reports: For each acoustical panel ceiling and components.

- H. Maintenance Data: For finishes to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
- B. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
 - 2. Suspension System: Obtain each type through one source from a single manufacturer.
- C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system through one source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
 - 1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - b. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.
- E. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.7 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed but not less than four (4) unopened boxes for each type and finish.
 - 2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.
 - 3. Hold-Down Clips: Equal to 2.0 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANELS, GENERAL

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance's, unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.
- B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by COR from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
- C. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or

bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

- A. ACT-1: Fiberglass Ceiling Panels: Subject to compliance with requirements, provide the product indicated on Drawings, or approved equal.
 - 1. Modular Size: 24" x 24" x 1-1/2"
 - 2. Edge Profile: Reveal
 - 3. Color: White
 - 4. NRC: 1.00
 - 5. CAC: 26
 - 6. Light Reflectance: 0.84
 - 7. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
 - 8. Fire Rating: Class A
 - 9. Grid Type: 15/16"
- B. ACT-2: Fiberglass Ceiling Panels: Subject to compliance with requirements, provide the product indicated on Drawings, or approved equal.
 - 1. Modular Size: 24" x 24" x 1-1/2"
 - 2. Edge Profile: Reveal
 - 3. Color: Black
 - 4. NRC: 1.00
 - 5. CAC: 26
 - 6. Light Reflectance: 0.03
 - 7. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
 - 8. Fire Rating: Class A
 - 9. Grid Type: 15/16"
- C. ACT-3: Ceramic and Mineral Fiber Composite Panels: Subject to compliance with requirements, provide the product indicated on Drawings, or approved equal.
 - 1. Modular Size: 24" x 24" x 5/8"
 - 2. Edge Profile: Square Lay-In
 - 3. Color: White
 - 4. NRC: 0.55
 - 5. CAC: 26
 - 6. Light Reflectance: 0.82
 - 7. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.

8. Fire Rating: Class A
 9. Grid Type: 15/16"
- D. ACT-4: Metal Clip-On Panels: Subject to compliance with requirements, provide the product indicated on Drawings, or approved equal.
1. Modular Size: 24" x 24"
 2. Edge Profile: 1/8" Reveal
 3. Perforations: M15 (Rd 1612)
 4. Color: Silverlume
 5. NRC: 0.90
 6. CAC: N/A
 7. Light Reflectance: 0.77
 8. Fire Rating: Class A
 9. Grid Type: 15/16"
- E. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements as indicated on Drawing S001 of the structural drawings.
- a. Type: Post installed expansion anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.

- 4. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
- G. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

2.4 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

- A. Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. BPB USA
 - 3. CertainTeed
 - 4. Chicago Metallic Corporation
 - 5. Ecophon CertainTeed, Inc.
 - 6. USG Interiors, Inc.

2.5 METAL EDGE MOLDINGS AND TRIM

- A. Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. BPB USA
 - 3. CertainTeed
 - 4. Chicago Metallic Corporation
 - 5. Fry Reglet Corporation
 - 6. Gordon, Inc.
 - 7. USG Interiors, Inc
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
 - 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
 - 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
 2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
 3. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
 4. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):
 - a. Manufacturer's standard, factory-applied prime-coat finish ready for field painting.
 5. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
 6. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - a. Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils.

2.6 ACOUSTICAL SEALANT

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.
 2. Acoustical Sealant for Concealed Joints:
 - a. OSI Sealants, Inc.; Pro-Series SC-175 Rubber Base Sound Sealant.
 - b. Pecora Corporation; BA-98.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counterplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 7. Do not attach hangers to steel deck tabs.
 - 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

- E. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. Install panels with pattern running in one direction parallel to short axis of space.
 - 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 - 3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 4. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
 - 5. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13

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SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. HVAC demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

B. Contractor Qualifications: The Contractor shall have a permanent mailing and street address, telephone number and shall have been in continual business of HVAC systems for not less than 5 years. The Contractor shall be duly licensed to install HVAC systems in the state where the construction is located. The Contractor shall be a member in good standing with the General or Mechanical Contractors Association. The prime contractor shall perform a minimum of 75% of the work. Only 25% will be allowed to be sub-contracted. The Contractor shall have previous HVAC system replacement experience with the FAA.

C. General: Work shall be performed in accordance with these specifications and good practice. No modifications to these specifications will be accepted without the expressed written approval of the COR. It is the Contractor's responsibility to document COR's approval of any such modifications prior to the execution of work. Requirements of these Specifications modified by any addenda, change orders, written approvals and written instructions issued by the COR, if any, shall be as specifically identified by Section and Paragraph in those addenda, change orders, written approvals and written instructions. Approvals of submittals are subject to additional limitations described elsewhere in these Specifications. System concept drawing sheets are for information only to show potential system arrangement. Field verifies information contained on these drawings and is responsible for design and installation of the system in accordance with the specifications. The bid drawings do not show all information necessary for installation of the system but are intended to be used as a guide for the purpose of designing the systems and preparing a bid.

D. Removal of Debris and Salvage: Remove rubbish and debris resulting from work on a daily basis. Debris shall be disposed of offsite. Rubbish not removed by the Contractor will be removed by the FAA and back charged to the Contractor. Removal of debris and rubbish from the premises shall be coordinated with the COR.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31, "Building Services Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting

electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 1. Known Acceptable Source:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 1. Known Acceptable Source:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Known Acceptable Source:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
1. Known Acceptable Source:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
1. Known Acceptable Source:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Known Acceptable Source:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- D. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 2. Existing Piping: Use the following:
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 3. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Section 07 92 00 "Joint Sealants" for materials and installation.
- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Section 07 84 13 "Penetration Fire stopping" for materials.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

- 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 03 30 00 "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Section 05 50 00 "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

3.9 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 23 05 00

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SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small, and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with NEMA MG-10 Energy Management Guide for Selection and use of Polyphase Motors.
- D. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION 23 05 13

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SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Flow meters.

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers gages and flow meters indicating manufacturer's number, scale range, and location for each.
- C. Product Certificates: For each type of thermometer gage and flow meter, signed by product manufacturer.
- D. Operation and Maintenance Data: For Thermometer and gages to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Palmer - Wahl Instruments Inc.
 2. Trerice, H. O. Co.
 3. Weiss Instruments, Inc.
 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Die-cast aluminum or brass, 7 inches long.

- C. Tube: Red or blue reading, organic liquid filled, with magnifying lens. Mercury shall not be used.
- D. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- E. Window: Glass.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. Palmer - Wahl Instruments Inc.
 - 3. Trerice, H. O. Co.
 - 4. Weiss Instruments, Inc.
 - 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Manufacturers: Same as manufacturer of thermometer being used.
- C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. Palmer - Wahl Instruments Inc.
 - 3. Trerice, H. O. Co.
 - 4. Weiss Instruments, Inc.
 - 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Peterson Equipment Co., Inc.
2. Sisco Manufacturing Co.
3. Trerice, H. O. Co.
4. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

2.5 TURBINE FLOWMETERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Badger Meter, Inc.; Industrial Div.
 - 2. ONICON Incorporated.
- B. Description: Insertion type for inserting turbine into piping and measuring flow directly in gallons per minute.
- C. Construction: Bronze or stainless-steel body; with plastic turbine or impeller and integral direct-reading scale.
- D. Pressure Rating: 150 psig minimum.
- E. Temperature Rating: 180 deg F minimum.
- F. Display: Visual instantaneous rate of flow.
- G. Accuracy: Plus or minus 2-1/2 percent.

2.6 VORTEX-SHEDDING FLOWMETERS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bailey-Fischer & Porter Co.
 - 2. Engineering Measurements Company.
 - 3. ISTECH Corporation.
 - 4. MCO/Eastech, Inc.
 - 5. Schlumberger Limited; Measurement Div.
 - 6. Venture Measurement.
- B. Description: Inline type for installing between pipe flanges and measuring flow directly in gallons per minute.
- C. Construction: Stainless-steel body; with integral transmitter and direct-reading scale.
- D. Pressure Rating: 1000 psig
- E. Temperature Rating: 500 deg F
- F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons
- G. Integral Transformer: For low-voltage power operation.
- H. Accuracy: Plus or minus 7/10 percent for liquids and 1-1/4 percent for gases.

2.7 PITOT-TUBE FLOWMETERS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Dieterich Standard Inc.
 - 2. Meriam Instruments Div.; Scott Fetzer Co.
 - 3. Preso Meters Corporation.
 - 4. Taco, Inc.
 - 5. Veris Industries.
- B. Description: Insertion-type, differential-pressure design for inserting probe into piping and measuring flow directly in gallons per minute.
- C. Construction: Stainless-steel probe of length to span inside of pipe; with integral transmitter and direct-reading scale.
- D. Pressure Rating: 150 psig minimum.
- E. Temperature Rating: 250 deg F minimum.
- F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.
- G. Integral Transformer: For low-voltage power connection.
- H. Accuracy: Plus or minus 1 percent for liquids and gases.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install liquid-in-glass thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic boiler and chiller.
 - 2. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
 - 3. Outside-air, return-air, and mixed-air ducts.
- B. Install dry -case-type, vapor -actuated dial thermometers at suction and discharge of each pump.
- C. Provide the following temperature ranges for thermometers:
 - 1. Heating Hot Water: 0 TO 160 deg F, with 2-degree scale divisions.
 - 2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

- B. Install dry -case-type pressure gages at chilled- ~~and condenser~~ water inlets and outlets of chillers.
- C. Install dry -case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
- C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.
- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install remote-mounting pressure gages on panel.
- F. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- G. Install test plugs in tees in piping.
- H. Install flow indicators, in accessible positions for easy viewing, in piping systems.
- I. Assemble and install connections, tubing, and accessories between flow-measuring elements and flow meters as prescribed by manufacturer's written instructions.
- J. Install flow meter elements in accessible positions in piping systems.
- K. Install flow meter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
- L. Install permanent indicators on walls or brackets in accessible and readable positions.
- M. Install connection fittings for attachment to portable indicators in accessible locations.
- N. Install flow meters at discharge of hydronic system pumps and at inlet of hydronic air coils.
- O. Assemble components and install thermal-energy meters.
- P. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.4 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

- B. Connect flow meter-system elements to meters.
- C. Connect flow meter transmitters to meters.

3.5 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron ball valves.
4. Iron, single-flange butterfly valves.
5. Bronze lift check valves.
6. Bronze swing check valves.
7. Iron swing check valves.
8. Iron, center-guided check valves.
9. Iron, plate-type check valves.
10. Chainwheels.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. RS: Rising stem.

1.3 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Solder Joint: With sockets according to ASME B16.18.
 - 3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Hammond Valve.
 - d. Jamesbury; a subsidiary of Metso Automation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
- B. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 - 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.

- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Hammond Valve.
- d. Jamesbury; a subsidiary of Metso Automation.
- e. Milwaukee Valve Company.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Forged brass.
- e. Ends: Threaded.
- f. Seats: PTFE or TFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel, vented.
- i. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Conbraco Industries, Inc.; Apollo Valves.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company.
- e. NIBCO INC.
- f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE or TFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel, vented.
- i. Port: Full.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Split body.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Ends: Flanged.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel.
 - i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Known Acceptable Source: Subject to compliance with requirements, available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bray Controls; a division of Bray International.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. DeZurik Water Controls.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- B. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bray Controls; a division of Bray International.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Division.
 - f. DeZurik Water Controls.
 - g. Hammond Valve.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

- e. Seat: NBR.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

C. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bray Controls; a division of Bray International.
 - b. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - c. Crane Co.; Crane Valve Group; Center Line.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. DeZurik Water Controls.
 - f. Hammond Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.

D. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:

1. Known Acceptable source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bray Controls; a division of Bray International.
 - b. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - c. Crane Co.; Crane Valve Group; Center Line.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. DeZurik Water Controls.
 - f. Hammond Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: NBR.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Nickel-plated or -coated ductile iron.

E. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Bray Controls; a division of Bray International.
- b. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. DeZurik Water Controls.
- f. Hammond Valve.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Tyco Valves & Controls; a unit of Tyco Flow Control.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Stainless steel.

F. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Bray Controls; a division of Bray International.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. DeZurik Water Controls.
- e. Hammond Valve.
- f. Milwaukee Valve Company.
- g. Mueller Steam Specialty; a division of SPX Corporation.

- h. NIBCO INC.
- i. Sure Flow Equipment Inc.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: NBR.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Stainless steel.

2.6 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.7 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.

- f. NIBCO INC.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Milwaukee Valve Company.
- e. NIBCO INC.

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 300 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

2.8 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.

- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

2.9 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and spring.

2.10 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hammond Valve.
 - b. Metraflex, Inc.
 - c. Milwaukee Valve Company.
 - d. Mueller Steam Specialty; a division of SPX Corporation.
 - e. NIBCO INC.
 - f. Spence Strainers International; a division of CIRCOR International.

- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-125.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron.
- d. Style: Compact wafer.
- e. Seat: Bronze.

B. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Hammond Valve.
- b. Metraflex, Inc.
- c. Milwaukee Valve Company.
- d. Mueller Steam Specialty; a division of SPX Corporation.
- e. NIBCO INC.
- f. Spence Strainers International; a division of CIRCOR International.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-125.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron.
- d. Style: Globe, spring loaded.
- e. Ends: Flanged.
- f. Seat: Bronze.

C. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. APCO Willamette Valve and Primer Corporation.
- b. Crispin Valve.
- c. Val-Matic Valve & Manufacturing Corp.

2. Description:

- a. Standard: MSS SP-125.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
- c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
- d. Style: Globe, spring loaded.
- e. Ends: Flanged.

- f. Seat: Bronze.

2.11 CHAINWHEELS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries.
 - 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball or butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile or cast iron Aluminum Bronze, of type and size required for valve.
 - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.

- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal -seat check valves.
- B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 CHILLED AND HOT-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze Angle Valves: Class 150, bronze disc.
 - 3. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
 - 4. Bronze Swing Check Valves: Class 150, bronze disc.
- B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM or NBR seat, aluminum-bronze disc.
4. Iron Swing Check Valves: Class 125, metal seats.
5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
6. Iron, Center-Guided Check Valves: Class 150, globe, metal seat.

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SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry, Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Signed and sealed by a qualified Licensed Professional Engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.

3. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Known Acceptable Source:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Grinnell Corp.
3. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Known Acceptable Source:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Power-Strut Div.; Tyco International, Ltd.
 - 3. Tolco Inc.
 - 4. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Known Acceptable Source:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Known Acceptable Source:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Hilti, Inc.
- c. ITW Ramset/Red Head.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.

6. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 7. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 8. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 10. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 11. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 12. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

3. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
4. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
5. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
6. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
7. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

- J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.
- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to maximum of 1 inch. Cover ends of support rods and other sharp edges with padding where sharp edges are hazard to operating personnel.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

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SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Pre-coiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White Yellow.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.5 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Reinforced grommet and wire or string.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings.
- B. Pipe Label Color Schedule: Provide colors per ANSI/ASME A13.1.

3.4 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 1. Blue: For cold-air supply ducts.
 2. Yellow: For hot-air supply ducts.
 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Chilled Water: 1-1/2 inches, round.
 - 2. Valve-Tag Color:
 - a. Chilled Water: Green.
 - 3. Letter Color:
 - a. Chilled Water: White.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC NEBB or TABB.
 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC NEBB or TABB.
 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with COR and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by COR and Commissioning Authority.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 PROJECT CONDITIONS

- A. Full FAA Occupancy: FAA will occupy the site and existing building during entire TAB period. Cooperate with FAA during TAB operations to minimize conflicts with FAA's operations.

- B. Partial FAA Occupancy: FAA may occupy completed areas of building before Substantial Completion. Cooperate with FAA during TAB operations to minimize conflicts with FAA's operations.

1.6 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 23 31 13 "Metal Ducts " and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural

Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 00 "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from COR and Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR HEAT EXCHANGERS

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.

- C. Measure inlet and outlet water temperatures.
- D. Check settings and operation of safety and relief valves. Record settings.

3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 - 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 - 6. Capacity: Calculate in tons of cooling.
 - 7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.12 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.14 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus 10 percent or minus 5 percent.
 - 3. Heating-Water Flow Rate: Plus 10 percent or minus 5 percent.
 - 4. Cooling-Water Flow Rate: 0 to Plus 10 percent.

3.15 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. COR's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:

- a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.

- d. Discharge static pressure in inches wg.
- e. Filter static-pressure differential in inches wg.
- f. Preheat-coil static-pressure differential in inches wg.
- g. Cooling-coil static-pressure differential in inches wg.
- h. Heating-coil static-pressure differential in inches wg.
- i. Outdoor airflow in cfm.
- j. Return airflow in cfm.
- k. Outdoor-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

- a. System identification.
- b. Location.

- c. Coil identification.
- d. Capacity in Btu/h.
- e. Number of stages.
- f. Connected volts, phase, and hertz.
- g. Rated amperage.
- h. Air flow rate in cfm.
- i. Face area in sq. ft.
- j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

- a. Heat output in Btu/h.
- b. Air flow rate in cfm.
- c. Air velocity in fpm.
- d. Entering-air temperature in deg F.
- e. Leaving-air temperature in deg F.
- f. Voltage at each connection.
- g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- M. Instrument Calibration Reports:
 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.

- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.17 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by COR and Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of COR and Commissioning Authority.
3. COR and Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, FAA may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Lagging adhesives.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.

- 7. Detail application at linkages of control devices.
- 8. Detail field application for each equipment type.

- C. Qualification Data: For qualified Installer.
- D. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Thermal Resistance Properties: Insulation and related materials shall be installed such that the minimum Thermal Resistance (R-value) of the insulation is installed to meet the requirements of ASHRAE 90.1-2010, for the applicable duct or pipe system and compatible with the operating temperatures of the system.
- C. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- D. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJComply with ASTM C 552, Type II, Class 2.
 - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

- F. Insulation integral to double-wall duct assemblies.
1. See specification 23 31 13 "Metal Ducts" for requirements of double-wall duct.
 2. Insulation integral to double-wall duct shall have minimum thermal resistance of R-4. Insulation may be fibrous blanket type or injected foam type. Insulation shall not be exposed to the air stream inside of the duct.
 3. Insulation integral to double-wall duct shall be compatible with operating temperatures of the system served, including a minimum of 20°F above and below the operating and ambient temperatures.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.
- H. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Knauf Insulation; Permawick Pipe Insulation.
 - b. Owens Corning; VaporWick Pipe Insulation.
- J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ or FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
 - d. Thermal Ceramics; FireMaster Duct Wrap.
 - e. 3M; Fire Barrier Wrap Products.
 - f. Unifrax Corporation; FyreWrap.
 - g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.3 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
4. Service Temperature Range: Minus 50 to plus 180 deg F.
5. Color: White.

2.7 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.

- c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
- 2. Width: 2 inches.
- 3. Thickness: 3.7 mils.
- 4. Adhesion: 100 ounces force/inch in width.
- 5. Elongation: 5 percent.
- 6. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
- 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
- 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
- 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

- 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
- 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, galvanized steel.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.

2.12 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. Color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and prepare surfaces to be insulated. Remove materials that will adversely affect insulation application.
- B. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.
- Q. PVC Jackets
 - 1. Provide a color coded jacket system for chilled water and domestic water systems. Colors shall be approved by FAA Contracting Officer's Representative.

3.4 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the

connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface.

Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.11 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 13 "Penetration Firestopping."

3.12 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

- C. Color: Final color as selected by COR. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
 - 2. Inspect field-insulated equipment, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.14 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in nonconditioned space.
 - 4. Indoor, exposed return located in nonconditioned space.
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.

6. Factory-insulated access panels and doors.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Indoor, concealed supply and outdoor air:
 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
 2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density. Applies to rectangular duct only.
 3. Minimum Thermal property: R-4.
- B. Indoor, exposed supply and outdoor air:
 1. Minimum Thermal property: R-4.
- C. Indoor, concealed return located in nonconditioned space:
 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
 2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density. Applies to rectangular duct only.
 3. Minimum Thermal property: R-4.
- D. Indoor, exposed return located in nonconditioned space:
 1. Minimum Thermal property: R-4.

3.16 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:
 1. Cellular Glass: 2 inches thick.
- D. Chilled-water pump insulation shall be the following:
 1. Cellular Glass: 3 inches thick.
- E. Chilled-water buffer and expansion tank insulation shall be one of the following:
 1. Cellular Glass: 2 inch thick.
- F. Chilled-water air-separator insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.

3.17 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Underground piping.
 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.18 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 1. Insulation shall be the following:
 - a. Cellular Glass: 1-1/2 inches thick.
- B. Chilled Water , above 40 Deg F:
 1. Insulation shall be the following:
 - a. Cellular Glass: 1-1/2 inches thick.
- C. Heating Hot-Water:
 1. Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
- D. Hot Service Drains:
 1. Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.
- E. Refrigerant Piping:
 1. Insulation shall be the following:

Flexible Elastomeric: 1 inch thick

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled-Water Supply and Return:
 - 1. Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.

3.20 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
 - 1. None.
- D. Ducts and Plenums, Exposed:
 - 1. None.
- E. Equipment, Concealed:
 - 1. None.
- F. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Corrugated: 0.032 inch thick.

G. Piping, Concealed:

1. None.

H. Piping, Exposed:

1. PVC, Color-Coded by System: 20 mils thick.

3.21 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. Aluminum, Corrugated: 0.032 inch thick.

END OF SECTION 23 07 00

SECTION 23 08 20 - HVAC COMMISSIONING - GENERAL

PART 1 GENERAL

1.1 DESCRIPTION

- A. The purpose of the Commissioning process is to provide the FAA with a higher level of assurance that the systems have been installed in the prescribed manner and will operate within the performance guidelines. The Commissioning Agency shall provide the FAA an unbiased, objective view of the systems' installation, operation, and performance. This process is not to take away or reduce the responsibility of the system designers or installing Contractor(s) to provide a finished product. It is not intended to be an additional or redundant testing/inspection function, but shall enhance the quality of system start-up and aid in the orderly transfer of systems to beneficial use by the FAA.
- B. The function and responsibility of the Commissioning Agency shall include:
 - 1. Responsibility: The primary point of responsibility to inform the FAA on the integration and performance of systems within the facility.
 - 2. Information: Disseminate information and assist the Contractor to complete the certification process. This shall include system completeness, performance, and adequacy to meet the intended performance standards of each system. Services include construction observation, testing, and providing performance information to the responsible parties, i.e., contractors, vendors, and FAA.
 - 3. Leadership/Training: Initiate and lead the involvement of the facility operations people in the Commissioning process. Setting standards, involving the technicians in the certification process and educating operations personnel on each system.
 - 4. Quality Assurance: Assist the responsible parties to obtain quality equipment, installation, and performance of systems.
 - 5. Arbitration of Disputes: The Commissioning Agency is to remain an independent party present on the project with specific knowledge of the project. Should disputes arise, the Commissioning Agency shall complete research to determine the scope and extent of the problem, educate the involved parties on the nature and extent of the problem. The Contracting Officer will preside over resolution of the dispute. This would include all technical and financial aspects of the dispute, including determination of who the responsible parties are to implement corrective actions.
 - 6. Observation of Tests: Observe and/or perform all required testing to certify adequate system performance.
 - 7. Documentation of Tests: Document the results of the performance testing directly and/or ensure that all testing is documented by the appropriate technicians. The Commissioning

Agency shall provide standard forms to be used by all parties for consistency of approach and type of information to be recorded.

8. Acceptance: Determine the date of acceptance for each component and system for start of the warranty period.
- C. The Commissioning Agency is referred to as an independent contractor in this Division and shall be a service provided by the Contractor for the FAA by a company approved by the FAA.

Known acceptable source:
Air Analysis of Atlanta, Inc (AAI)
1520 Pine Log Road, Suite 1
Conyers, Georgia 30012
Mr. Gene White
770-929-3165

1.2 COORDINATION

- A. The Commissioning Agency shall coordinate directly with each contractor on the project specific to their responsibilities and contractual obligations. If the contractor is a sub-contractor to another contractor, written information shall be provided to all responsible parties relative to the nature and extent of the communication. If contractual obligations are in question, then the prime contractor shall be contacted by the Commissioning Agency to determine the extent and scope of responsibilities and change orders, if appropriate.
- B. The Commissioning Agency is primarily responsible to the FAA, and as such, shall regularly apprise the COR of progress, pending problems or disputes, and shall provide regular status reports on progress with each system. Any potential change in the contractual and/or financial obligations of the FAA shall be identified as soon as they are known. Any such change shall be quantified as soon as possible.
- C. Refer to other HVAC Commissioning Sections for additional details as to the expectations of the Commissioning Agency with respect to specific systems.

1.3 SCHEDULE

- A. Commissioning of systems shall proceed per the criteria established in the other Division 18 sections, with activities to be performed on a timely basis. The Commissioning Agency must be available to respond promptly to avoid Contractor delay.
- B. Commissioning of systems may proceed prior to final completion of systems to expedite progress. However, the Commissioning Agency shall not perform testing and check out services that are the primary responsibility of the contractor/vendor in advance of their testing and checkout.
 1. Problems observed shall be addressed immediately, in terms of notification to responsible parties, and actions to correct deficiencies.
 2. Schedules and scheduling is the responsibility of the Contractor. Commissioning requirements must be coordinated with the approval of the Contractor. The Commissioning Agency

must provide commissioning scheduling information to the Contractor for their review and planning activities.

1.4 RELATED WORK

- A. Commissioning is the primary responsibility of the Commissioning Agency, with secondary and support responsibility by the Contractor. The commissioning process does not relieve the sub-contractors from participation in the process or diminish their role and obligations to complete all portions of work in a satisfactory and fully operational manner.
- B. Participation by the Commissioning Agency shall include the following work as specified in this division:
 - 1. Observation of the start-up and initial testing by the Contractor.
 - 2. Provide qualified personnel for participation in commissioning tests, including seasonal testing required after the initial commissioning.
 - 3. Provide engineering and technical expertise to oversee and direct the correction of deficiencies found during the commissioning process.
 - 4. Review operation and maintenance information and as-built drawings provided by the various Contractors and vendors for verification, organization, and distribution.
 - 5. The contractors and vendors shall provide assistance to the commissioning team to develop and edit operation descriptions by system.
 - 6. Assist with training for the systems specified in Division 15 in coordination with the Contractor.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All industry standard test equipment required for performing the tests specified herein shall be provided by the Commissioning Agency, with proprietary vendor specific test equipment to be provided by the manufacturer.
- B. The Commissioning Agency's instrumentation shall meet the following standards:
 - 1. Be of sufficient quality and accuracy to test and/or measure system performance within the tolerances required to determine adequate performance.
 - 2. Be calibrated on the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument being used.

3. Be maintained in good repair and operating condition throughout the duration of use on this project.
4. Be recalibrated/repared if dropped and/or damaged in any way during use on this project.

PART 3 - EXECUTION

3.1 BASIS OF DESIGN DOCUMENTATION

- A. Provide narratives to include design criteria and design intent for each system as itemized in Section 3.2 below, with the addition of all supply and exhaust air-handling systems.

3.2 ONE-LINE DIAGRAMS

- A. One-line diagrams shall be required to support narrative system descriptions and the overall commissioning process. Depending on the system in question, the following procedures for developing the one-line diagram are to be employed:
- B. Update the existing riser diagrams that have been provided in the Contract Documents. Some revisions may be required to match desired format for Commissioning Documents. This method shall be employed for the following systems:
 1. Hot Water Heating
 2. Air Handling Equipment
 3. Chilled Water Cooling

3.3 OPERATING DESCRIPTIONS BY SYSTEM

- A. A narrative shall be prepared describing the operation of each system. The Contractor shall develop from the contract specifications the draft document, the vendors shall have input into editing these narratives, and subsequently the Contractor shall then complete another interim edit. Subsequently, the Contractor shall oversee training, re-editing, and publishing of the final operations narratives.

3.4 MAINTENANCE PROCEDURES

- A. A narrative is to be prepared describing the Maintenance Procedures required for each system. The Contractor shall develop from the contract specifications the draft document, the vendors and manufacturer's representative shall have input into editing these narratives, and subsequently the Contractor shall then complete another interim edit. Subsequently, the Contractor shall oversee training, re-editing, and publishing of the final maintenance procedures.

3.5 TECHNICAL REFERENCE MANUALS

- A. Compile and organize vendor-provided equipment technical reference materials. This function includes gathering, inventory, editing, and review.

- B. The equipment manufacturer must provide standard technical literature relative to the operation and maintenance of the provided equipment. The literature shall be specifically orientated to the provided equipment indicating all operation and maintenance procedures, parts lists, assembly/disassembly diagrams, and related information. Wiring diagrams must be complete and specific to the equipment provided.
- C. The Commissioning Agency must incorporate the standard technical literature into a systems specific format for this facility as designed, and as actually installed. The resulting operation and maintenance information shall be system specific, concise, and to the point, and above all tailored specifically to this facility.

3.6 OBSERVE CONSTRUCTION

- A. This is an additional and separate activity from that provided by the COR. This is additional construction observation required as part of the commissioning process to be provided by the Commissioning Agency.

3.7 TEST AND BALANCE

- A. Air and water balance and equipment capacity verification shall be completed by an independent Test and Balance firm under contract to the Contractor in accordance with Specification Section 23 05 93.

3.8 FUNCTIONAL PERFORMANCE TEST PROCEDURES

- A. Personnel experienced in the technical aspects of each system to be commissioned shall develop and document the commissioning procedures to be used. Include a performance checklist and performance test data sheets for each system based upon actual system configuration. These procedures shall be reviewed and edited by the appropriate Commissioning Agency engineers for technical depth, clarity of documentation, and completeness. Special emphasis shall be placed on testing procedures that shall conclusively determine actual system performance and compliance with the design intent.
- B. The majority of mechanical equipment requires integral safety devices to stop and/or prevent equipment operation unless minimum safety standards or conditions are met. This could include adequate oil pressure, proof-of-flow, non-freezing conditions, maximum head pressure etc. The Commissioning Agency must observe the actual performance of safety shutoffs in a real or closely-simulated condition of failure.
- C. Systems may include safety devices and components that control a variety of equipment operating as a system. Interlocks may be hardwired or installed via software. These interlocks shall also be verified by the Commissioning Agency.
- D. The Commissioning Agency must determine the acceptance procedures for each system within Divisions 23 disciplines. The acceptance procedures must incorporate the commissioning standards and successful testing results as referred to throughout Divisions 23 specifications.

- E. The appropriate contractor and vendor(s) must be informed before commissioning is started what the tests and expected results will be. Whereas some test results and interpretations may not become evident until the actual test are performed, all parties should have a reasonable understanding of the requirements. The commissioning plan must address those requirements and be distributed to all parties involved with that particular system.
- F. Acceptance procedures must confirm the performance of systems to the extent of the design intent. When a system is accepted, the FAA must be assured that the system is complete, works as intended, is correctly documented, and is trained in the operation and maintenance of the system.

3.9 REVIEW SOFTWARE DOCUMENTATION

- A. Review vendor/contractor provided detailed software documentation. This includes obtaining vendor documentation, a review of their programming approach, and a review of the specific software routines as applied to this project. Discrepancies in protocol or programming approaches shall be resolved to provide the FAA with the most appropriate, simple and straightforward approach to software routines.

3.10 FUNCTIONAL PERFORMANCE TESTING-OBSERVATION

- A. The functional performance test shall be done by the contractors and vendors. The appropriate engineers and technicians who have significant field expertise with the appropriate system shall witness, verify, and assist with the tests.
- B. Tests shall be completed comprehensively and to the extent to enable the Commissioning Agency to assure the FAA that the systems do perform to the full intent of the design. Once a system has successfully passed the performance testing, as addressed by the Commissioning Agency, the Commissioning Agency shall become responsible to the FAA for adequate system performance with reasonable margin for normal system degradation and given normal operation and maintenance procedures.

3.11 TRAINING

- A. Provide assistance in coordination with the Contractor for operations training for the FAA's staff for each system using videotape documentation. Training shall be in a classroom setting with the appropriate schematics, handouts and visual/audio training aids.
- B. The Commissioning Agency shall host each training session with program overview and curriculum guidance.
- C. The equipment vendors shall provide training on the specifics of each system and philosophy, troubleshooting, and repair techniques.
- D. The installation contractors shall provide training on peculiarities specific to this project and job specific experience.

3.12 RECORD DRAWINGS

- A. Provide assistance to the Contractor in production of the red-line As-Built contract documents to incorporate design changes and contractor records of construction.

3.13 COMMISSIONING PLAN AND SCHEDULE

- A. The Commissioning Agency shall develop an integrated schedule for the Commissioning Process with the construction schedule. Included shall be the required work by all team members, contractors, and FAA. (Overlay with construction schedule, functional performance testing, and input to contractors).

3.14 EXCLUSIONS

- A. Responsibility for construction means and methods. The Commissioning Agency is not responsible for construction means, methods, job safety, or any management function on the job site.
- B. Hands-on work by the Commissioning Agency. The Contractor shall provide all technician services requiring tools or the use of tools to test, adjust or otherwise bring equipment into fully operational state. The Commissioning Agency shall observe technicians as they complete testing, and may make minor adjustments, but shall not perform construction or technician services other than normal test and balance functions.

END OF SECTION 23 08 20

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SECTION 23 08 21 - HVAC COMMISSIONING – HVAC SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

- A. The purpose of this section is to describe the general commissioning process specific to the HVAC systems and equipment. HVAC systems include electric heating, chilled water, supply air, exhaust air systems and a portion of the life safety systems. The following is provided as a typical scope of the work expected to be performed by the Commissioning Agency.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The majority of the HVAC test equipment will be provided by the test and balance contractor as part of their normal service. Special test equipment for electrical systems testing will be provided by the electrical contractor.
- B. The Commissioning Agency will ensure that proper and correct test equipment is available by the appropriate contractors. If equipment is missing, inappropriate, or not available to those contractors, the Commissioning Agency will be responsible for procuring and making available the correct equipment.

2.2 TEST EQUIPMENT - PROPRIETARY

- A. Proprietary test equipment shall be provided by the manufacturer of the equipment to be commissioned. The manufacturer's representative shall provide the equipment, demonstrate use of the test equipment, and assist the commissioning agency in the commissioning process. Proprietary test equipment shall become the property of the FAA upon completion of commissioning.

PART 3 - EXECUTION

3.1 CONSTRUCTION OBSERVATION

- A. Obtain and review design documents for overall design intent and the overall required systems configurations.
- B. Obtain and review shop drawings and submittals for installation criteria and the required construction details, as they support and further define the systems features.
- C. The Commissioning Agency shall make general inspections at the job site and shall review the following for configuration, quality of construction, adherence to design requirements, and conformance with shop drawings and submittal information.

D. The Commissioning Agency shall provide periodic observations of the HVAC systems equipment, ductwork, and piping systems as constructed. Observations shall commence with arrival of major components on the job site and continue through the construction phase and into the start-up phases of work. In addition to general observation services, the Commissioning Agency will make note of, or obtain, the following specific system features:

1. Prime Movers/Major Equipment:

- a. Fans, Pumps, Chillers, and Boilers:
 - i. Condition of equipment as delivered/installed
 - ii. Equipment data/compliance with specifications and shop drawings
 - iii. Performance curves
 - iv. Installation per design documents

2. Accessories:

- a. Supply, Return, and Exhaust Air Systems:
 - i. Balancing dampers/fit and integrity
 - ii. Fire dampers/fit and integrity
 - iii. Control dampers/fit and integrity
 - iv. Smoke dampers/fit and integrity
 - v. Isolation dampers/fit and integrity
- b. Chilled Water Systems:
 - i. Balance cocks/location and accessibility
 - ii. Flow stations/location and accessibility
 - iii. Strainers/location and accessibility and strainer mesh
 - iv. Isolation valves/location and accessibility
 - v. Control valves/location and accessibility

3. Distribution Systems:

- a. Duct:
 - i. Size and configuration
 - ii. Fittings/transitions and takeoffs
 - iii. Seams and joints/integrity and sealing
 - iv. Hangers and bracing
 - v. Connections
 - vi. Sealing/sealers and joints
 - vii. Thickness per specifications/SMACNA standards
- b. Pipe:
 - i. Size and configuration
 - ii. Fittings
 - iii. Connections
 - iv. Hangers and bracing
 - v. Materials per specifications

4. Terminal Units:

- a. Air Terminal/Boxes:
 - i. Number, size, configuration per plans and specifications
 - ii. Balance dampers (if applicable)
 - iii. Controls components and configurations
 - iv. Entrance and exit conditions per requirements
- b. Coils:
 - i. Supply and return piping connections
 - ii. Ductwork transitions
 - iii. Sealing of duct penetrations
 - iv. Fin integrity and straightness

5. Controls:

- a. Components and configurations per shop drawings
- b. Organization and layout of control panels
- c. Sensors in proper locations
- d. Wiring and pneumatic piping per specifications
- e. Labeling and identification/all components, wiring, and piping

3.2 CLEANING

See individual subsections.

3.3 EQUIPMENT SAFETY DEVICE CHECKS

See individual system commissioning procedures.

3.4 ACCEPTANCE PROCEDURES

See individual system commissioning procedures.

END OF SECTION 23 08 21

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SECTION 23 08 23 - HVAC COMMISSIONING – SUPPLY AIR SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

- A. The purpose of this section is to describe the commissioning process specific to the supply air systems and equipment. The following is provided as a typical scope of the work expected to be performed by the Commissioning Agency.

PART 2 – PRODUCTS

2.1 TEST EQUIPMENT

- A. The majority of the HVAC test equipment will be provided by the test and balance contractor as part of their normal service. Special test equipment for electrical systems testing will be provided by the electrical contractor.
- B. The Commissioning Agency will ensure that proper and correct test equipment is available by the appropriate contractors. If equipment is missing, inappropriate, or not available to those contractors, the Commissioning Agency will be responsible for procuring and making available the correct equipment.

2.2 PROPRIETARY TEST EQUIPMENT

- A. Proprietary test equipment shall be provided by the manufacturer of the equipment to be commissioned. The manufacturer's representative shall provide the equipment, demonstrate use of the test equipment and assist the commissioning agency in the commissioning process. Proprietary test equipment shall become the property of the FAA upon completion of commissioning.

PART 3 - EXECUTION

3.1 CONSTRUCTION OBSERVATION

- A. Obtain and review design documents for overall design intent and the overall required systems configurations.
- B. Obtain and review shop drawings and submittals for installation criteria and the required construction details, as they support and further define the systems features.
- C. The Commissioning Agency shall make general inspections at the job site and shall review the following for configuration, quality of construction, adherence to design requirements, and conformance with shop drawings and submittal information.

- D. The Commissioning Agency shall provide periodic observations of the HVAC systems equipment, ductwork, and piping systems as constructed. Observations shall commence with arrival of major components on the job site, and continue through the construction phase and into the start-up phases of work. In addition to general observation services, the Commissioning Agency will specifically observe the following specific system features:
1. Prime Movers/Major Equipment:
 - a. Fans:
 - 1) Condition of equipment as delivered/installed/damage/cleanliness
 - 2) Equipment data/compliance with specifications and shop drawings
 - 3) Performance curves/configuration per submitted documents
 - 4) Installation per design documents/plans and specifications
 - 5) Equipment mounting and anchoring devices
 - 6) Vibration isolation devices
 2. Accessories/Supply Air Systems:
 - 1) Balancing dampers/fit and integrity/locking quadrants
 - 2) Fire dampers/fit and integrity/fusible links
 - 3) Control dampers/fit and integrity/seals/linkage/motor mounting
 - 4) Smoke dampers/fit and integrity/linkage/motor mounting.
 - 5) Isolation dampers/fit and integrity/seals/linkage/motor mounting
 3. Distribution Systems/Ductwork:
 - 1) Size and configuration
 - 2) Fittings/transitions and takeoffs
 - 3) Seams and joints/integrity and sealing
 - 4) Hangers and bracing
 - 5) Flexible connections
 - 6) Sealing/sealers and joints
 - 7) Thickness per specifications/SMACNA standards
 - 8) Lining (if applicable) per SMACNA standards
 4. Terminal Units:
 - a. Air Terminal/Boxes:
 - 1) Number, size, configuration per plans and specifications
 - 2) Balance dampers (if applicable)
 - 3) Controls components and configurations
 - 4) Entrance and exit conditions per requirements
 - 5) Sound attenuation per plans and specifications
 - 6) Entrance conditions to box/length of straight runs

b. Coils:

- 1) Supply and return piping connections
- 2) Ductwork transitions
- 3) Sealing of duct penetrations
- 4) Fin integrity and straightness

5. Controls:

- 1) Components and configurations per shop drawings
- 2) Organization and layout of control panels
- 3) Sensors in proper locations
- 4) Wiring per specifications
- 5) Labeling and identification/all components, wiring, and piping

3.2 CLEANING

See Division 23 requirements.

3.3 TESTS

- A. Prefab Built-up Air-Handling Units Air Leakage: Perform housing air leakage test as specified in Division 23. Leakage rate shall not exceed more than 1 percent of system air quality.
- B. Duct Leakage Test: Test all ductwork including low pressure ductwork in accordance with test method described in Section 5 of SMACNA-HVAC Air Duct Leakage Test Manual, except the test pressure shall be equal to duct pressure class.

3.4 EQUIPMENT SAFETY DEVICE CHECKS

- A. The majority of mechanical equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met. This could include proof-of-flow, non-freezing conditions, smoke and/or fire alarms, etc. The Commissioning Agency must observe the actual performance of safety shutoffs in a real or closely simulated condition of failure.
- B. Systems may include safety devices and components that control a variety of equipment operating as a system. Interlocks may be hardwired or installed via software. These interlocks shall also be verified by the Commissioning Agency. Refer to design documents for required interlocks and test each as required.

END OF SECTION 23 08 23

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SECTION 23 09 23 –CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 RELATED SECTIONS

- A. This section includes the Building Management System (BMS) control equipment for HVAC (Heating, Ventilation and Air Conditioning) systems and components, including but not limited to Servers, Network Controllers, Field Bus Controllers, Sensors, End Devices and communication networks required for a complete and functional control system.
- B. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section, including several from Division 23

1.3 DEFINITION OF TERMS AND ABBREVIATIONS

- A. Architecture for BMS Systems:

1. Bus Topology: A term used to describe the sequential connection of devices on a LON segment. The communication cable runs from device to device with no tees or stubs from the main communication cable to a device. Also referred to as daisy chain wiring.
2. Channel: A LON network consisting of one segment with no LON routers or repeaters or multiple segments connected by repeaters.
3. Field Bus: Field bus is a generic term referring to control networks that connect multiple control devices that share a common protocol and common electrical communication characteristics. A field bus does not use TCP/IP for data transfer. Two very common examples are the FT-10A LON field bus and the RS485 Shielded Twisted Pair field bus.
4. Free Topology: A data wiring topology supported by LON that allows for loops, tees, y-connections, etc. When this topology is used, only one terminator of a specific design is required and allowable cable lengths are significantly reduced.
5. LAN (Local Area Network): A LAN is an organizations IP network serving a local area where data transfer between multiple components on the LAN does not involve transport over public physical IP networks.
6. LON to LON Router: A physical device used to connect two channels. These devices filter message traffic based on subnet numbers.
7. Repeater: A physical device used to connect two segments. A repeater does not filter any message traffic. A repeater does isolate physical problems such as short circuits to a single segment and is typically required to allow the use of additional devices or additional cable length.
8. Terminator: An electronic component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communications on a segment. With bus

topology, a termination device is required at both ends of the segment. With free topology, only one termination device is required at any point on the network.

9. WAN (Wide Area Network): This is also referred to as the Enterprise Network. The WAN is an organizations IP network that is made up of a collection of Local Area Networks (LAN) belonging to the organization. Dataflow between LANs may utilize public physical networks but the dataflow is private and secure.
 - a. BMS Control Components: The detailed technical specifications for the following components are included in Section 2.
 - 1) ASC (Application Specific Controller): A subset of application specific devices (ASD). An ASC has physical inputs, physical outputs and control logic. It does not fit in the category of sensor or end device. Example: Xenta 102AX VAV controller.
 - 2) ASD (Application Specific Device): A sensor, controller, or end device that is pre-programmed by the vendor. It may have physical inputs and physical outputs. The control logic, while not programmable, may be configurable through the use of configuration parameters. The application may require input network variables and may send output network variables. Example: Xenta 422A IO Device when commissioned in a stand-alone mode
 - 3) DCU (Distributed Control Unit): A proprietary name for a programmable process controller in the INET product line.
 - 4) ES (Enterprise Server): A computer hosted server that coagulates the databases from multiple Network Server Controllers. Example: SmartStruxure Enterprise Server
 - 5) NSC (Network Server Controller): An IP level controller and router. It connects to the IP level of the system architecture to multiple field busses that use LonTalk, BACnet MSTP and ModBus RTU. It may also support a field bus that uses a proprietary protocol such as the Schneider Electric INET protocol. Example: SmartStruxure Automation Server
 - 6) PEM (Packaged Equipment Module): An application specific controller that is native to a HVAC equipment item. Within the HVAC industry these controllers will typically fall into one of three categories; LON, BACnet or Modbus. Example: A VFD with an integral LON communications card
 - 7) PCU (Process Control Unit): A proprietary name for a programmable process controller in the INET product line.
 - 8) PPC (Programmable Process Controller): A controller with provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air-handling unit, chiller or boiler. The control logic for the sequence of control is created using an application programming editor that is compatible with the controller. A programmable process controller may or may not have data management features such as time schedules, trend data storage and alarm message generation capabilities. These features may be provided by another device using network communication to and from the PPC. Example: Xenta 302 Programmable Controller
 - 9) SLC (Supervisory Logic Controller): A device that does not use physical inputs or physical outputs. It collects data over the network from other devices, applies logic to the data, generates instructions for use by other

devices and sends the instructions to the appropriate device. Example:
Xenta 401B Programmable Controller

- 10) Add other device descriptions as necessary.

b. BMS Tools and Software

- 1) Application Programming Tool: A software tool used to create control logic for use in a Network Server Controller, a Programmable Process Controller or a Supervisory Logic Controller. Application Programming Tools are vendor unique and may require a separate operating license.
- 2) Graphical Programming: A concept where mathematical and logical algorithms are represented by graphical objects. Control logic is laid out by placing objects on a palette and connecting the output of one object to the input of the next object.
- 3) Graphics Editor: A software tool use to create dynamic graphical displays. A Graphics Editor is vendor unique and may require a separate operating license.
- 4) Line Programming: Application programming that uses line by line code that is similar to FORTRAN, Basic or C+ programming. Master programs and subroutines are created to meet a sequence of control.
- 5) LON Network Configuration: The process of addressing devices in an ANSI/EIA 709.1 environment. Also the process used to implement LON bindings between devices in the same ANSI/EIA 709.1 environment.
- 6) Web Server: Software that is installed on an Enterprise Server and/or Network Server Controllers to enable access by an operator using an industry standard web browser such as Internet Explorer or Google Chrome.
- 7) Workstation Presentation Software: Vendor unique software that allows an operator to access an Enterprise Server and/or a Network Server Controller for operation or engineering purposes.

c. Communication

- 1) Bandwidth Utilization: The average utilization of the LON FT-10A network in percent measured over a specified period of time as measured by a protocol analyzer.
- 2) Data Propagation Parameters: To ensure appropriate data transfer from device to device without excessive bandwidth utilization, sending devices will utilize a combination of communication parameters.
 - a) Maximum Send Time: An adjustable parameter that defines the maximum time period between multiple transmissions of the same data element. This parameter ensures periodic data transfer even if the data has not changed its state or value.
 - b) Minimum Send Time: An adjustable parameter that defines a mandatory time period during which the device must wait prior to sending the same data element a second time. This parameter ensures that data is not sent too often resulting in excessive bandwidth utilization.
 - c) Send on Delta: An adjustable parameter that defines a requirement to send an element of data as a result of the data changing by an amount

that exceeds this parameter's value. For binary data, a change of state is the default. Minimum send time and maximum send time parameters have priority over send on delta. Between the minimum send time and the maximum send time, the send on delta will govern the sending of data.

- d) The maximum send time parameter is mandatory.
 - e) Either the minimum send time parameter or the send on delta parameter must be used. Both may be used. When minimum send time is not used, the system performs as if the minimum send time is zero seconds.
- 3) LON Binding: The concept of associating an output network variable on a LON device to an input network variable on a second LON device.
 - a) One-One: A single network variable is bound to a single input network variable.
 - b) One-Many: A single network variable is bound to input network variables on multiple devices.
 - 4) LON Binding Services: The description of how data is sent from device to device using LON bindings.
 - a) Unacknowledged: The data is transmitted once. No acknowledgement is expected.
 - b) Unacknowledged/Repeated: The data is transmitted multiple times with a delay between each send. No acknowledgement is expected. The number of sends and the time between sends is typically adjustable.
 - c) Acknowledged: The data is transmitted and the sending device waits for an acknowledgement message from the receiving device. If an acknowledgement message is not received within a specified period of time, the process will be repeated. This binding service is never used on a one-many binding.
- d. Control Applications
- 1) Algorithm Execution Sample Rate: How often a mathematical algorithm in a controller generates a new or updated value.
 - 2) Analog Calibration Offsets: For all analog input measured variables, there is a requirement to adjust the value measured by the hardware based analog input point to match the value reported by a certified test instrument.
 - 3) Dead Zone: With respect the performance of a PID algorithm, the dead zone is the range of an input variable to the PID above and below the set point for which the output of the PID algorithm shall not be changed. Once the input variable gets within the dead zone, it is fruitless to attempt changes to get the input variable any closer to the set point. Assigning a dead zone to a PID loop improves stability and reduces wear and tear on the actuator.
 - 4) Dynamic Data: Data that is calculated within control logic and is viewable by the system operator.

- 5) Floating Control: Floating control is a control loop algorithm used for fast responding airside and waterside pressure and flow control loops. Key parameters are the set point, the neutral zone, the bump rate and the algorithm sample rate.
- 6) Forced by Operator: Sometimes referred to as Manual Control. When a software object is “Forced by Operator”, the value or state of the object is assigned by the operator and a value or state that flows to the object from another object or by physical measurement is blocked.
- 7) PID: Proportional-Integral-Derivative control. Key parameters are the set point, the gain, the interval time constant, the derivative time constant and the dead zone. Integral gain is defined as the gain divided by the interval time constant. Derivative gain is defined as the gain multiplied by the derivative time constant.
- 8) Points: Software objects associated with physical inputs and physical outputs (sensors and end devices). Input points receive their value or state from a sensor. Output points receive their value or state from the control logic.
- 9) User Adjustable Parameters: Parameters within the control logic that have a fixed but adjustable value or state. The value or state is set by the system operator. The parameters are initially programmed with a default value.

e. Equipment

- 1) AHU (Air Handling Unit)
- 2) FCU (Fan Coil Unit)
- 3) FPU (Fan Powered Unit)
- 4) TU (Terminal Unit)
- 5) VAV (Variable Air Volume)
- 6) VFD (Variable Frequency Drive)
- 7) EDH (Electric Duct Heater)
- 8) HWC (Hot Water Coil)
- 9) CH (Chiller)
- 10) CWS (Chilled Water Supply)
- 11) CWR (Chilled Water Return)
- 12) CWP (Chilled Water Pump)
- 13) B (Boiler)
- 14) HWS (Hot Water Supply)
- 15) HWR (Hot Water Return)
- 16) BYP (Bypass)

f. Facilities

- 1) FAA facilities are typically operational 24/7. As such, some work in existing facilities may require off normal work hours.

g. Qualified System

- 1) The DDC Control System shall be the SmartStruxure System as manufactured by Schneider Electric.

- a) Field Bus Controllers for new work shall be from the Xenta LON family of field bus controllers.
 - b) The b3 BACnet, MNL Lon and MNB BACnet field bus controllers under SmartStruxure shall not be used for new work.
- 2) Integration of existing Schneider Electric INET Field Bus Controllers may also be part of the proposed solution. Protocol Translation Gateways shall not be used for these integrations.
- 3) HVAC components with integral PEMs that utilize one of the following protocols may be part of the proposed solution.
 - a) LONtalk
 - b) BACnet MSTP
 - c) BACnet IP
 - d) ModBus RTU
 - e) ModBus TCP
- h. Pre-Approved Bidders: Only pre-approved installers are eligible to perform work on Terminal FAA projects. The following companies are known to be pre-approved installers for this project.
 - 1) Future Controls, Inc., 5719 Zip Drive, Suite 1, Fort Meyers, Florida 33905, 800-330-1303, Attn: Thomas Hansen, Jr.
 - 2) C-Tech, 116 Portland Road, Whitehouse, Tennessee 37188, 615-672-8210, Attn: Jim Brown.
- i. Qualifications:
 - 1) All work described in this document shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office.
 - 2) The approved manufacturer's local field office shall have a minimum of 3 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package to verify this requirement has been met.
 - 3) Supervision, hardware and software engineering, calibration, tuning and functional testing of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted.
 - 4) The BMS contractor shall have factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system.
 - 5) The BMS contractor shall have 24 hour per, 7 days per week emergency service available.

1.4 SCOPE OF WORK

- A. The contractor shall furnish, install and commission a complete building automation system including all necessary hardware, networks, wiring, custom applications and operating software required to perform the control sequences of operation as called for in this specification and on

the contract drawings. The complete building automation system may include the integration of existing Schneider Electric INET systems. Refer to the Contract Drawings for INET system requirements. Systems to be controlled shall include but not be limited to:

1. Air Handling Units (AHU)
2. Chilled Water System including the chiller, pumps and heat rejection systems
3. Variable Air Volume Terminal Units with and without fans and reheat
4. Constant Air Volume Terminal Units with and without fans and reheat
5. Monitoring and Control points for packaged equipment such as emergency generators.
6. Hot Water System including the boilers, pumps, and heat rejection systems.

B. The complete building automation system shall, as a minimum, include the following items. The technical specifications for each of these items are included in Part 2 of this document.

1. All necessary Operator Work Stations, Enterprise Servers, and Network Server Controllers at the WAN/LAN level of the system architecture.
2. All necessary Field Bus Controllers at the field bus level of the system architecture.
3. All necessary WAN/LAN controllers that use the BACnet IP or ModBus TCP protocols.
4. All necessary sensors, transducers, relays, valves, valve operators, dampers, damper operators, control panels and other accessory equipment.
5. All necessary network wiring and electrical interlocking wiring to meet the intent of the specification and provide a complete and operable system.

a. All wires shall be labeled at both ends to facility wire tracing

6. All necessary networking components such as Lon to Lon Routers, Lon Repeaters and network termination devices.
7. All control components shall be labeled so that the component can be easily associated with the design drawings/submittals.
8. All network wiring and hardware required to integrate existing Schneider Electric INET systems as required by the contract drawings.
9. Power wiring to BMS panels, BMS components and smoke control dampers except as otherwise specified. Power wiring shall be provided under Division 26 (Electrical).
10. Except as otherwise specified, provide operators for equipment such as dampers and valves on equipment provided by other contractors when these items are not provided as part of the equipment provided by the other contractors.
11. All custom applications in the Enterprise Server, Network Server Controllers, Programmable Process Controllers and Supervisory Logic Controllers.
12. Fully configured applications in all application specific devices.
13. All modifications to Schneider Electric INET applications required to enable the combined systems to meet the complete sequences of operation.
14. All trend logs required by this specification and the contract drawings.
15. All alarms with alarm routing required by this specification and the contract drawings.
16. All operator graphic pages required by this specification and the contract drawings.

C. Work Associated With Other Contractors

1. The BMS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each

- contractor shall consult the drawings and specifications for all trades to determine the nature and extend of others' work
2. The BMS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor.
 3. The BMS Contractor shall provide field supervision to the designated contractor for the installation of the following.
 - a. Automatic control dampers
 - b. Blank-off plates for dampers that are smaller than duct size
 - c. Sheet metal baffles plates to eliminate stratification
- D. Calibration: Calibration of all analog sensors under normal operating conditions. Off season calibration may be required for this task. Example: Calibrating a chilled water temperature sensor must be accomplished when the chilled water system is in operation. Submission requirement for calibration plans and reports are described in the Submittal section of this document.
- E. Loop Tuning: Tuning of all P, PI and PID control loops under normal operating conditions. Off season tuning may be required for this task. Example: A mixed air damper control loop is not in operation when the outside air temperature is 90 deg F. A mixed air damper control loop is typically in modulation mode when the outside air temperature is less than 60 deg F. Submission requirement for loop tuning plans and reports are described in the Submittal section of this document.
- F. System Start-Up and Start-Up Testing.
1. The BMS contractor shall set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, working in a support role to the Mechanical Contractor. The Owner's representatives shall have the opportunity to be present.
 2. Start-Up Testing is the process of verifying the system is physically complete and properly installed in accordance with the approved installation submittals.
 - a. It does not include calibration of analog sensors as the systems may not be in a state to support calibration efforts.
 - b. It does not include loop tuning as the systems may not be in a state to support loop tuning.
 - c. It does not include functional testing.
 3. Start-Up Testing may be accomplished on a per component basis.
 - a. Each Network Server controller with its embedded physical IO may be the subject of one Start-Up Test.
 - b. Each Field Bus Controller with its connected physical IO may be the subject of one Start-Up Test.
 - c. Each network can be tested as part of a Start-Up Test.
 4. Start-Up Testing may be accomplished on a per control panel basis where a control panel contains multiple components.

5. Start-Up Testing tasks shall include as a minimum the following.
- a. Verification of component inventory compared to the submittals
 - b. Measurement of voltage sources; line voltage, low voltage AC and DC
 - c. Verification that the power consumption of all devices connected to a single power source does not exceed the power capacity of the power source
 - d. Verification that devices that required half wave power are not powered from the same source as devices that require full wave power
 - e. For each controller, verification of correct controller:
 - 1) Power wiring (voltage, VA, full wave versus half wave)
 - 2) Grounding
 - 3) Communication wiring
 - f. Verification that each IO device is landed per the submittals and:
 - 1) Analog sensors are properly scaled and a value is reported
 - 2) Binary sensors have the correct normal position and the state is correctly reported
 - 3) Analog outputs have the correct normal position and move full stroke when so commanded
 - 4) Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
 - g. For each communication network, verification of:
 - 1) Bus topology
 - 2) Polarity is consistently maintained device to device on RS485 networks
 - 3) Shielded wire is used where required
 - 4) Wire characteristics match the type required (LON, RS485)
 - 5) The AWG of the cable does not change within a single segment and it is per the submittals
 - 6) Single point grounding of shields and continuity of the shield over each segment of the network (when shielded wire is used)
 - 7) The installation of the correct terminal devices at the both ends of each segment (FT-10A Networks)
 - 8) Terminal resistors are installed at the end of each segment for RS485 networks
 - 9) Biasing power sources and resistors are properly installed per the design.
 - 10) The installed unit load of RS485 devices does not exceed the calculated maximum.
 - h. For all wiring verify that:
 - 1) All wires are labeled such that both ends of each wire can be easily identified
 - 2) Connection integrity and quality is good (no loose strands and no loose connections)
 - 3) All cabling shall be installed “uncut” in a single continuous run from starting point to ending point without splices when practical. (Note: at a

minimum, conductors within the same room, same system, and common origin shall be considered practical).

6. Submission requirement for start-up testing plans and reports are described in the Submittal section of this document.

G. Functional Testing

1. When the system is fully installed and operational, the BMS contractor shall execute functional tests of the system in the presence of representatives of the owner.
2. The functional tests shall be written by the BMS contractor and shall be designed to verify all aspects of the sequence of operation. Off season functional testing may be required for some tasks.
3. Submission requirement for functional testing plans and reports are described in the Submittal section of this document.
4. Support for HVAC and Balancing Contractors: Provide software tools, services and manpower as necessary so that the HVAC and Balancing Contractors are equipped to accomplish their functional testing and balancing tasks. The HVAC and Balancing Contractors will not be familiar with the BMS operator interface. The BMS Contractor may provide tools and training for these contractors to make them self sufficient or provide a trained operator to support their efforts.

H. Support for Commissioning Agent: If an independent Commissioning agent effort is part of this project, the BMS Contractor shall provide software tools, services and manpower as follows so that the agent is equipped to perform commissioning tasks.

1. Submit a Commissioning Agent Support Plan as define in the Submittals Section of this document.
2. HVAC systems primarily consist of:
 - a. Energy Source Systems such as chillers, boilers, etc.
 - b. Energy Delivery Systems such as air handling units or piping systems.
 - c. Terminal Units such as Fan Coil Units, VAV Terminals, Unit Heaters, Heat Pumps, etc.
 - d. Third Party End Devices such as VFDs
3. The BMS Contractor shall provide an engineering technician that was significantly involved with the installation of the BMS System and is fully trained to operate the installed system. This technician shall:
 - a. Using Contract Documents and Facility Architectural Plans, brief the Commission Agent on the location of BMS components within the facility.
 - b. Furnish custom tools and cables that are unique to the BMS and not generally available in the commercial market.
 - c. Execute operator tasks as instructed by the commissioning agent.
 - d. Make minor engineering changes to the system such as adding trend logs, changing parameter values, overriding automatic control, etc.
 - e. Extract performance data from the BMS system for the Commissioning Agent.
4. The BMS Contractor personnel shall not be tasked to assist in the physical tasks associated with verifying system performance such as accessing system components,

taking measurements, observing the physical status of end devices, etc. The primary task for the supporting technician is to operate the BMS system.

5. The BMS Contractor shall provide support to the Commissioning Agent in accordance with the following manpower budget:
 - a. 16 Man-hours for each energy source system
 - b. 16 Man-hours for each energy delivery system
 - c. 2 Man-hours for each terminal device.
 - d. 4 Man-hours for each third party device
 - e. 16 Man-hours for operator interaction tasks.
 - f. Man-hours not expended for one system shall be available for other systems.
 - g. The BMS Contractor is responsible for providing manpower to support CX, T&B and FAA turnover demonstrations.
6. When repeat testing is required by the Commissioning Agent as a result of the system not meeting the contract requirements during the first test, BMS Contractor support shall be provided at no additional cost to the Owner.

I. Operator Interaction Testing

1. When the system is fully installed and operational, the BMS contractor shall execute operator interaction tests of the system in the presence of representatives of the owner. This can be combined in the training specified in the next section.
2. These tests shall be written by the BMS contractor and shall be designed to verify all aspects of operator interaction with the system. Additional requirements will be found in the System Acceptance and Testing section of this document.
3. Test elements shall include but not be limited to:
 - a. Graphics navigation
 - b. Alarm viewing, acknowledging, inhibited and routing
 - c. Viewing trend log lists and trend charts
 - d. Time schedule editing
 - e. Application/configuration parameter adjustment
 - f. Viewing data in the system tree
 - g. Manual control of all objects that are equipped for this function
 - h. Viewing reports
 - i. Viewing application programs in the ES, NSCs, PPCs and SLCs (Engineering Workstation Only)
 - j. Using the Search Function
4. Unless otherwise noted, verify that the above tasks can be accomplished from the Engineering Workstation and Web-Based Operator Workstations.
5. Submission requirement for operator interaction testing plans and reports are described in the Submittal section of this document.

J. Training

1. On-site training shall be focused on the tasks that are described in the Operator Interaction Testing Plan.

- a. Training will be customized to reflect operation of the delivered system.
- b. Training shall be provided for up to 10 of the Owner's personnel.
- c. As part of the training, each student shall have the opportunity to perform each of the tasks in the testing plan.
- d. Training shall consist of 1 session at turnover and 1 session 3 months afterward (This provides the operators time to work on the system between sessions). First Session – 2 days, 8 hours each. Second Session – 1 day, 8 hours.

K. Submittals: The contractor is required to submit technical information to the owner hereafter referred to as "Submittals" at three different phases of the project:

- 1. Pre-Construction
- 2. During Construction
- 3. Post-Construction.

L. The requirements for each submittal are described later in this document.

M. Quantity Review: The BMS contractor shall review the entire specification and all contract drawings to determine the systems to be controlled, the operation sequences and the quantities and types of dampers, valves, operators, sensors, transducers, end devices required for a complete operational control system and to be provided by the BMS contractor.

1.5 WORK BY OTHERS

A. The Electrical Contractor shall provide:

- 1. All power wiring to motors, heat trace and junction boxes for power to BMS panels
- 2. Wiring between the smoke detectors and the building fire alarm system
- 3. Auxiliary contact (pulse type) on electric meters for central monitoring of kWh and KW by the BMS
- 4. The scaling parameters for the auxiliary contact on the electric meters to enable engineering of the electrical monitoring by the BMS contractor.

1.6 CODES, LAWS AND GOVERNING BODIES

- A. All work performed under this section of the specification will comply with all governing codes, laws and governing bodies.
- B. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the Owner, shall submit a proposal with appropriate modifications to the project to meet code requirements. If this specification and/or drawings exceed governing code requirements, the specification and drawings will govern.
- C. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.7 CODE COMPLIANCE

- A. BMS components and ancillary equipment shall be UL-916 listed and labeled as such.

- B. All equipment and piping used in conditioned air streams, spaces or return air plenums shall comply with NFPS 90A Flam/Smoke/Fuel contribution ratings of 25/50/0 respectively and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electric Code.
- D. Computing devices and low power communication equipment shall comply with FCC rules, Part 15 regarding Class A radiation in commercial environments.

1.8 SYSTEM DESCRIPTION

- A. Operator Interfaces: In accordance with the scope of work and contract drawings, the system shall provide a graphical web-based operator interface that allows the operator to view data from and send data or commands to any system under control by the BMS through the use of a standard browser. The system shall also provide a personal computer based engineering workstation to allow system operators to perform engineering tasks such as editing applications, editing or creating graphics and adding new devices to the system. This engineering workstation shall also function as an operator workstation without the use of a standard browser and as an administrator workstation to allow the system administrator to establish secure access to the system and define dataflow between users and the system on a per user and user group basis.
 - 1. The BMS contractor shall provide one (2) administrator and engineering workstations as described in Part 2 of this document. One (1) desktop with a minimum of 24" flat screen monitor and one (1) laptop with a minimum of a 15" screen. These workstations shall physically connect to the WAN/LAN layer of the system architecture.
 - a. From this workstation the system operator shall be able to connect to the Enterprise Server and see the entire BMS system or connect to an individual Network Server Controller and see the systems controlled by the Network Server Controller and the field bus controllers managed by the Network Server Controller.
 - b. From this workstation, the operator shall be able to perform all engineering and administrative tasks to install, program, configure, commission and operate the presented BMS system.
- B. Enterprise Server (ES): ****Only used in the case where an INET integration is required.**** The BMS contractor shall provide an Enterprise Server that connects to the system at the WAN/LAN layer of the system architecture.
 - 1. The ES shall provide visibility into the databases in all of the Network Server Controllers as well as its own database via an Engineering Workstation or Web-based Workstations.
 - 2. The ES shall be able to send and receive data from any Network Server Controller for implementation of the system wide sequence of operation.
 - 3. The ES shall be able to:
 - a. Host applications as necessary to meet the system wide sequence of operation.
 - b. Upload and store trend log data from all Network Server Controllers.
 - c. Host system wide graphical data displays.
 - d. Host master time schedules for mirroring in Network Server Controllers.

- e. Host master calendars for integration with time schedules.
- 4. The ES shall support the use of the following for communication at the WAN/LAN layer of the system architecture using web services:
 - a. HTTP: Hyper Text Transfer Protocol
 - b. SOAP: Simple Object Access Protocol
 - c. XML: eXtensible Markup Language
- 5. The ES shall be able to send and receive data to/from WAN/LAN based ModBus devices using ModBus Transmission Control Protocol (ModBus TCP).
- 6. The ES shall support the tunneling of LON ANSI/EAI 709.1 data over the IP in accordance with the ANSI/EIA 852-B standard.
- 7. The ES shall support the use of BACnet over IP using UDP.
- C. Network Server Controllers: The BMS contractor shall provide, install and commission one (1) or more Network Server Controllers as necessary to meet the control requirements defined in this document and the requirements of the manufacturer's architectural guidelines.
 - 1. These controllers will communicate with the following devices via the WAN/LAN with the capability to communicate at 100 bits per second.
 - a. The Enterprise Server
 - b. Other Network Server Controllers
 - c. Operator Workstation
 - d. Engineering Workstation
 - e. Web-based operation workstations
 - 2. These controllers shall communicate with their embedded input and output devices via a dedicated bus.
 - 3. These controllers shall communicate with LON field bus controllers via a dedicated 76.8 kilobit per second FT-10A LON field bus network.
 - 4. These controllers shall communicate with up to 3 distinct RS485 networks. Use of the RS485 networks shall be selected from the following:
 - a. ModBus RTU devices via a dedicated RS485 shielded twisted pair field bus network.
 - b. BACnet MSTP devices via a dedicated RS485 shielded twisted pair field bus network.
 - c. INET DCUs and PCUs via a dedicated RS485 shielded twisted pair field bus network.
 - d. When using RS485 devices under a Network Server Controller, the loading of the Network Server Controller must conform to vendor recommendations on the simultaneous use of the multiple RS485 networks and number of devices per network. In most cases, one of the three options will dominate with very limited loading on the other two RS485 networks.
 - 5. The Network Server Controllers shall support the use of:
 - a. Modbus TCP

- b. BACnet over IP using UDP
- 6. The Network Server Controllers shall support the use of the following for communication at the WAN/LAN layer of the system architecture using web services:
 - a. HTTP: Hyper Text Transfer Protocol
 - b. SOAP: Simple Object Access Protocol
 - c. XML: eXtensible Markup Language
- 7. Network Server Controllers shall NOT communicate with the Enterprise Server or any workstation using RS232 or ARCNET.
- D. Field Bus Controllers: Field Bus Controllers consist of Application Specific Devices, Programmable Process Controllers, Supervisory Logic Controllers and Packaged Equipment Modules. With limited exceptions, all field bus controllers shall be compatible with the EIA Standard 709.1 LonTalk™ protocol and be installed on a FT-10A LON field bus connected to one of the Network Server Controllers without the use of gateways or protocol translators.
 - 1. These controllers shall have embedded FT-10A Transceivers to allow for connection to a FT-10A LON Network at 76.8 kilobits per second.
 - 2. These controllers shall be LonMark certified or LonMark compatible.
 - 3. Exceptions.
 - a. In some cases, packaged equipment modules are not available with support for the LonTalk™ protocol. In such cases, devices that utilize BACnet MSTP, BACnet IP, ModBus RTU or ModBus TCP shall be used.
 - b. These exceptions must be clearly defined on the pre-construction submittals.
- E. Networks: The networks that allow for connection of the components that make up the BMS system shall exist in two layers; the Ethernet/IP layer (WAN/LAN) and the field bus layer. The devices that transition from the WAN/LAN layer to the field bus layer are Network Server Controllers.
 - 1. WAN/LAN
 - a. Enterprise Ethernet (IEEE 802.3), WAN: This network shall utilize CSMA/CD, ARP and UDP operating at 10 or 100 Mbps.
 - b. Local Area TCP/IP Network, LAN: This network shall be either a 10 or 100 Mbps Ethernet network supporting BACnet Over IP, Modbus TCP, Java, XML, HTTP, SOAP and COBRA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers, an Enterprise Server, and multiple workstations (engineering or web-based).
 - 2. Field Bus Layer: Field Bus Networks shall be FT-10A LON or RS485 Twisted Shielded Pair.
 - a. FT-10A LON networks using the EIA Standard 709.1 LonTalk™ protocol shall connect to a Network Server Controller and support devices with FT-10A transceivers.

- b. RS485 Shielded Twisted Pair networks to support devices with RS485 transceivers shall connect to a Network Server Controller.

F. Environmental Control Equipment

- 1. The BMS system shall use electronic sensors and electronic/electric actuation of valves, dampers and two position electric circuits on central station HVAC equipment, HVAC terminal equipment, variable frequency drives, low voltage lighting control, electrical circuit breakers and power monitoring.
- 2. The BMS is intended to seamlessly connect devices throughout the building regardless of system type.

G. WAN/LAN Reliability

- 1. A Network Server Controller and all field bus controllers that are subordinate to the NSC represent a defined subset of the overall BMS.
- 2. Each NSC system shall be designed for the maximum possible stand alone operation when the NSC can no longer communicate with other NSC or ES systems on the WAN/LAN.
- 3. When a specific piece of measured data (Example: Outside Air Temperature) is critical to the performance of two NSC systems, each NSC system shall have its own electronic sensor (to measure the Outside Air Temperature).
- 4. When schedules and set points originate in the ES, each NSC system shall hold the last data received from the ES until communication with the ES is re-established or the NSC system shall revert to local applications until communication with the ES is re-established.

H. Software Tools: Latest Licensed software at time of commissioning. Tools shall be provided in their original electronic format and be installed and configured on the appropriate devices for each software tool.

- 1. Enterprise Server: Software tools to address and configure the Enterprise Server for complete ES functionality.
- 2. Network Server Controllers: Software tools to address the NSC and to load the latest firmware into the NSC.
- 3. Field Bus Controllers: Software tools to address the field bus controllers and to load the latest firmware into the field bus controllers.
- 4. Custom Application Engineering: Software tools to create custom applications for the ES, NSCs and programmable Field Bus Controllers.
- 5. Application Specific Device Configuration: Software tool to configure parameters in application specific devices
- 6. Graphics Editor: Software tool to create dynamic graphic displays (pages) in the ES and NSCs.
- 7. License Administration: Software tool to manage all licenses for full and complete operation of the BMS system.
- 8. Workstation: Software to enable operation of the Engineering and Administrative operator workstation.
- 9. Web-Workstation: Software for the ES and NSCs to enable operation of web-based operator workstations.

10. Any other software required for a complete system that can execute all of the tasks defined in this document. The intent of this specification is that the Owner's system operators shall not be restricted from performing any operator or engineering task due to the absence of software or licenses.
11. The capability for simultaneous execution of tasks from multiple points of entry into the system is described in Part 2 of this document.

I. Custom Tools and Cables

1. One set of all custom tools and cables that are acquired from the BMS manufacturer and used during installation, configuration and engineering of the system.

J. Graphics

1. The type, quantity and technical requirements for graphic pages are described in Part 2 of this document.
2. Graphic pages that relate to systems and components that are controlled by a Network Server Controller (or devices on a field bus managed by the Network Server Controller), shall be located in the Network Server Controller.
3. Graphic pages that relate to systems and components that are controlled by multiple Network Server Controllers shall be located in the Enterprise Server.

K. Trend Log Data

1. Trend log data for values in a field bus controller.
 - a. If trend log data is collected in a field bus controller, the trend log data must be periodically uploaded to larger capacity trend logs in the Network Server Controller.
 - b. If trend log data is not collected in a field bus controller, the data to be trended shall be mirrored in the Network Server Controller and the mirrored data shall be logged in the Network Server Controller. The mirroring process shall use send on delta, minimum send time and maximum send time parameters to avoid excessive bandwidth utilization on the field bus.
2. Data that originates in the Network Server Controller shall be trended in the Network Server Controller.
3. Trend log data in the Network Server Controller shall be periodically uploaded to long term data storage in the Enterprise Server when applicable/provided.
4. All trends shall be local to the Smart Struxure Software and shall be set to the following: 15 minute snapshot / 14 day storage.

1.9 SUBMITTALS

A. Shop Drawings and Product Data.

1. Shop drawings shall be 11 inch by 17 inch, landscape, bound on the left edge. Organize the packages by building.

2. All text based documents and product data sheets shall be 8 ½ inch by 11 inch format bound on the left edge. To the maximum extent possible Adobe Acrobat shall be used to produce the documents in an X.pdf format.
3. Software files shall be submitted on fully labeled CDs that shall include a table of contents file in “filename.pdf” format that provides a description of all of the files on the CD.

B. Submittals Prior To Construction.

1. Shop Drawings

a. System Architecture Design Diagram.

- 1) This is a riser diagram of the WAN/LAN layer, all NSCs and all connected field busses. It shall show all BMS components to be installed on the WAN/LAN and all of the field busses.
- 2) This diagram shall include the existing control systems that are to be integrated into the common enterprise level system.
- 3) The physical relationship of one component to another component shall reflect the proposed installation. Example: If AHU1 controller is the closest controller to NSC on the field bus, then this device shall be shown as the first device on the riser diagram just below the NSC. This requirement does not apply to the existing control system.

b. Layout Design Drawing for each control panel:

- 1) All control devices shall be identified by name.
- 2) All terminal strips and wire channels shall be shown.
- 3) All control transformers and 120 VAC receptacles shall be shown.
- 4) All IP connection points shall be shown.

c. Wiring Design Diagram for each control panel.

- 1) The control voltage wiring diagram shall clearly designate devices powered by each control transformer
- 2) The LON wiring diagram shall clearly show the order in which the devices are connected to the LON and the location of end of segment termination devices.
- 3) If shielded communication wiring is used, the grounding location for the shield shall be shown.
- 4) The terminal strip wiring diagram shall identify all connections on both sides of the terminal strip. Wiring label numbers for all wiring leaving the control panel shall be annotated on the diagram.

d. Wiring Design Diagram for individual NSCs and Field Bus Controllers: The wiring diagram for each component shall identify all I/O, power and communication wiring, and the locations on the terminal blocks to which wires are landed. Example: Fan Status sensor is wired from terminals 5/6 on the controller to terminals 17 and 18 on the terminal strip.

e. Installation Design Detail for each I/O device.

- 1) Include a drawing of the wiring details for each sensor and/or end device.
 - 2) For devices with multiple quantities a standard detail may be submitted.
 - f. A System Flow Design Diagram for each controlled system.
 - 1) A two dimensional cross sectional diagram showing key components such as fans, coils, dampers, valves, pump, etc.
 - 2) Identify the locations and names of all sensors and end devices that are associated with the control system. Label the panel name and terminal numbers where the connections are landed.
 - 3) A legend shall be provided for all symbols used.
2. Data
 - a. BMS manufacturer's architectural guidelines that define the systems architecture, the number of devices supported at each level of the architecture and any other software or hardware limitations for an efficient system.
 - b. BMS Hardware Technical Data.
 - 1) A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number.
 - 2) Manufacturer's description and technical data for each unique device to include performance curves, product specification sheets and installation instructions. When a manufacturer's data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.
 - 3) An Instrumentation List for each system. The list shall be in a table format and Include name, type of device, manufacturer, model number and product data sheet number.
 - c. Sequence of Control: A sequence of control for each system being controlled.
 - 1) A list of all physical inputs and outputs associated with each sequence.
 - 2) Identify those points that shall be subject to manual control from an operator workstation.
 - 3) A list of all alarms, a description of the alarm and a description of the alarm criteria.
 - 4) A list of all variables for which historical trending will be applied, the sample rates and any criteria used to start and stop the historical trending.
3. Submit five (5) copies of submittal data and shop drawings to the Owner for review and approval prior to ordering or fabrication of the equipment.
4. The Owner will annotate required corrections and return to the BMS Contractor. The BMS Contractor will then re-submit with corrected data or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Owner and the submittals are fully approved.
5. Startup Testing Plan: Submit a startup testing plan for each unique system.

- a. The purpose of a startup test is to demonstrate the “completeness” of the physical tasks associated with installation and the physical performance of the components. See the Scope of Work Section in this document for a task list.
- b. For each task on the startup test checklist, the plan shall require the technician to enter his or her initials and the date the test was completed along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.
- c. Submit at least four weeks prior to any scheduled start-up tests.
6. Performance Verification Testing Plan: Submit a verification plan for each system. For each end device that is controlled, the plan shall define a series of step by step cause and effect tests to verify each aspect of the sequence of control.
7. Performance Verification Testing Report: Performance Verification Testing Reports shall be submitted on a per system basis. Performance Verification Testing reports shall be the documented results of the executed performance verification testing plans with initials and dates.
8. Calibration Report: A calibration report shall be submitted on a device by device basis listing the analog sensors that were calibrated and the final calibration offsets for each sensor.

C. Submittals After Construction

1. As-built system architecture drawing.
2. As-Built layout drawing for each control panel.
3. As-built wiring diagram for each control panel.
4. As-built wiring diagram for individual components.
5. As-built system flow diagram for each controlled system.
6. As-built Instrumentation list for each controlled system.
7. As-built sequence of control.
8. Operation and Maintenance Manuals: Operations and Maintenance Manuals shall consist of two parts. Both parts shall be provided electronically on each workstation with links to the information from the home page. Diagrams shall be on 11” by 17” files. If color has been used to differentiate information, the copies shall also be in color.
 - a. Part I: Information common to the entire system.
 - 1) Product manuals for key software tasks.
 - a) Operating the system.
 - b) Administrating the system.
 - c) Application programming.
 - d) Engineering the network.
 - e) Graphics creation.
 - f) Reports creation.
 - g) All other engineering tasks.
 - 2) List of recommended maintenance tasks associated with the Enterprise Server, Network Server Controllers and Engineering Workstation.
 - a) Define the task and the recommended frequency.

- 3) Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
- 4) Licenses, guarantees, and warranty documents for equipment and systems.
- 5) Submit three (3) copies of Part I information.

b. Submit one copy for each building, plus two extra copies.

D. Interface with the Owner's IP Infrastructure

1. The system shall be on a stand-alone TCP/IP infrastructure and shall not be connected to the FAA backbone at any time.

1.10 OWNERSHIP

A. The BMS Contractor may use temporary licenses during the installation and commission of the system, but permanent licenses without expiration dates shall be installed on the system prior to completion. These license files shall be provided to the owner as part of the post construction submittals and they shall become the property of the owner.

B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract.

1. The license agreement shall grant use of all software programs, firmware files, application library files, graphical symbol library, files created by the contractor during engineering and installation and product documentation to the owner.
2. The Owner shall agree to the terms of the license agreement that protect the manufacturer's right to non-disclosure of Trade Secrets contained within all files provided to the owner.
3. The licensing agreement shall not preclude the use of the software and firmware by individuals under contract to the Owner for commissioning, servicing or altering the system in the future.
4. The Owner shall agree that use of the software and firmware by individuals under contract to the owner shall be restricted to use on the Owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

C. All software programs and tools, firmware files, application library files, graphics libraries and product documentation used on this project shall be provided to the Owner in a format that the Owner could install them on a computer or download them to a control component. This shall include but not be limited to:

1. All software programs and tools listed in Section 1.9.8
2. Firmware files for all control components if the components allow for firmware updates
3. Xif files and NXE files for each type of Application Specific device
4. Application files created during project engineering and installation
5. Graphic files created during project engineering and installation
6. Graphic symbol and graphic component library files
7. Data sheets, installation manuals, engineering manuals and operator manuals for all components in the system

8. Application files, graphic files and other files created during engineering of the project that are intrinsic to the system database and can be easily extracted from the database do not have to be separately provided to the owner.

1.11 WARRANTY AND MAINTENANCE

- A. All components, system software and parts furnished and installed by the BMS Contractor shall be guaranteed against defects in materials and workmanship for 1 year after substantial completion.
- B. Labor to repair, reprogram or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period.
- C. Materials furnished by not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor than originally installed the product.
- D. All corrective software, firmware and application modifications made during warranty periods shall be updated on all owner documentation and owner digital files from previous submittals. The intent of this specification is that the BMS contractor will work with the Owner to ensure that what was submitted during post construction submittals is updated to reflect the changes made.

PART 2 - PRODUCTS

2.1 PRE-APPROVED MANUFACTURERS

- A. Electric Components: Schneider Electric Field Devices
- B. Electronic Components: Schneider Electric Field Devices
- C. Direct Digital Control Systems: Schneider Electric

2.2 SYSTEM ARCHITECTURE

- A. General
 1. The system architecture shall consist of two layers; the WAN/LAN layer and a Field Bus layer. Network Server Controllers are the devices that transition the field bus layer to the WAN/LAN layer. The field bus layer consists of two unique types: FT-10A LON and RS-485 for Modbus RTU, BACnet MSTP and INET.
 2. WAN/LAN Connected Devices: The following components shall connect to the WAN/LAN.
 - a. Network Server Controllers
 - b. Enterprise Server Computer
 - c. Engineering Workstation Computer
 - d. Operator Workstations (Web-Based)
 - e. ModBus TCP Controllers

- f. BACnet IP Controller
- 3. Field Bus Connected Devices: the following components shall connect to one of the field bus types.
 - a. Application Specific Devices: FT-10A
 - b. Programmable Process Controllers: FT-10A
 - c. Supervisory Logic Controllers: FT-10A
 - d. Packaged Equipment Modules: FT-10A and/or RS-485
 - e. INET Controllers: RS-485
- 4. System Segmentation:
 - a. System operators and engineers shall be able to connect using workstation software or a web browser to the Enterprise Server and interact with the entire system database in a single presentation.
 - b. System operators and engineers shall be able to connect using workstation software or a web browser to a single Network Server Controller and interact only with the database in the NSC and the devices on the field bus(s) that connect to the NSC.
- 5. Standard Network Support:
 - a. All NSCs, Servers and Workstations shall completely independent of the Owner's Ethernet TCP/IP LAN/WAN. The DDC system shall reside on a dedicated system and shall not interfere nor interact with the FAA LAN system.
- 6. System Expansion:
 - a. The Owner shall have the ability to expand the capacity of the system architecture by adding more NSCs with their associated connected field busses. This process shall not require additional software for the servers or workstations. This expansion capability shall extend to a maximum of 250 Network Server Controllers.
 - b. The Owner shall have the ability to expand the number of Engineering Workstations with the purchase of additional Workstation software licenses and the purchase of additional engineering tool licenses if simultaneous use of the engineering tools by more than one engineer is desired.
- 7. Fault Tolerance:
 - a. The failure of one component within the system architecture shall not cause the entire system to fail. All system users shall be notified by the alarm management system when a component fails.
 - b. Failure of the Enterprise Server shall not prevent operator connection to any of the Network Server Controllers.
 - c. Failure of a Network Server Controller shall not negatively affect the Enterprise Server or the other Network Server Controller. The Enterprise Server may no longer present the database from the failed NSC and its subordinate field bus controllers.

8. Operator/Engineer Access:

- a. The Enterprise Server shall support the simultaneous connection of up to 30 operators using Workstation or Web Browser software.
- b. A Network Server Controller shall support the simultaneous connection of up to 5 operators using Workstation or Web Browser software.
- c. The Enterprise Server shall support the simultaneous use of engineering tools by up to 2 engineers connected to the ES. A connection for engineering purposes may also consume one operator connection.
- d. A Network Server Controller shall support the use of engineering tools by only one engineer connected to the NSC. A connection for engineering purposes may also consume one operator connection.

9. FT-10A LON Field Bus:

- a. The cable shall be unshielded twisted pair, rated for FT-10A use by the supplying vendor, and between AWG20 and AWG24. The same AWG shall be used for the entire field bus. The wiring type and length limitation shall conform to Echelon's Junction Box and Wiring Guideline for Twisted Pair LonWorks Networks.
- b. Each segment shall have no more than 55 devices connected excluding the NSC and any repeaters or LON routers.
- c. Each segment shall have a termination device installed at both ends.
- d. Bus topology is mandatory. No tees, stubs or free topology is allowed.
- e. A LON repeater may be installed to add a second segment.
- f. A LON to LON router may be connected to the segment that is connected to the NSC to create a multi-channel field bus. All segments in a multi-channel environment must be terminated at both ends. The LON to LON router shall support smart mode and not require commissioning.
- g. Specific NSC/Xenta Lon Node Limitations: In addition to the limitation of 55 connected devices per segment, the following limitations must be met.
 - 1) When Xenta controllers are used under a NSC, the total number of connected devices shall not exceed 64 excluding the NSC connection, repeater connections, router connections and expansion IO modules for Xenta programmable process controllers.
 - 2) The number of Xenta programmable process controllers shall not exceed 30. The difference between 64 and the number of Xenta programmable process controllers may be used for Xenta 100s, ASDs and PEMs.
 - 3) Expansion IO modules for Xenta programmable process controllers shall be installed on the same segment as the Xenta programmable process controller they support.
- h. The LON outer sheathing shall be yellow in color.

10. RS-485 Field Bus:

- a. The cable shall be shielded twisted pair between AWG 20 and AWG 24. The same AWG shall be used for the entire field bus. The cable shall be rated for RS-485 installations by the supplying vendor.

- 1) Cable Impedance shall be 120 Ohms
 - 2) Cable Capacitance Wire to Shield shall be less than 25 picofarads per foot
 - 3) Cable Capacitance Wire to Wire shall be less than 13 picofarads per foot
- b. Device to device, polarity shall be maintained with the same wire always connected to the Data + terminal on each device and the second wire always connected to the Data – terminal on each device.
 - c. The initial RS-485 field bus shall start at the Network Server Controller.
 - d. Bus Topology shall be used. No tees or stubs are allowed no matter how short.
 - e. An RS-485 repeater may be used to extend the overall length of the RS-485 field bus. When a repeater is used, this creates a multi-segment field bus.
 - f. RS-485 segments shall not be longer than 4,000 feet.
 - g. The shield shall be continuous over an entire segment. Shield tie terminals on controllers may only be used if they are not connected to earth ground within the controller. If ungrounded tie terminal are not available a wire nut shall be used to keep the shield continuous.
 - h. The shield shall be connected to earth ground at the NSC. The shield for the initial segment shall not touch earth ground at any other location along the segment. Care shall be taken to ensure no accidental earth ground connections are made within control cabinets.
 - i. If a RS-485 repeater is used to create a second segment, the shield for the second segment shall be connected to earth ground on the downstream side of the repeater.
 - j. 120 ohm termination resistors shall be installed at both ends of each segment. The resistor shall be connected between the Data + and Data – terminals. Care shall be taken to ensure that the resistor leads do not touch earth ground or the shield.
 - k. The outer cable sheathing shall be color coded as follows:
 - 1) Mod-bus = Purple
 - 2) BacNet = Gray
 - 3) INET = Blue
 - 4) INET sublan = Orange
11. RS-485 Network Biasing:
- a. The contractor shall determine the key characteristics of each controller's transceiver. This information shall be included in the product submittals. Combinations are:
 - 1) Failsafe, Isolated
 - 2) Failsafe, Non-Isolated
 - 3) Non-Failsafe, Isolated
 - 4) Non-Failsafe, Non-Isolated
 - b. If "Any One" controller on a segment has a Non-Failsafe transceiver, the segment shall require biasing. If "All" devices on a segment have Failsafe transceivers, the segment shall not require biasing.
 - c. If a segment requires biasing, it shall be installed at both ends of the segment.
 - d. For this installation, biasing shall be defined as a 5 VDC floating power supply connected to the Data + and Data – cables through 1,000 ohm resistors. The positive 5 VDC shall be connected to one end of a 1,000 ohm resistor. The other

end of the resistor shall be connected to the Data + terminal. The negative 5 VDC shall be connected to one end of a second 1,000 ohm resistor. The other end of this second resistor shall be connected to the Data – terminal. By “Floating” power supply, we are referring to the fact that the negative 5 VDC is not connected to earth ground.

- e. Cross Connections: Given the connection of communication wire, termination resistors and biasing, it is important to use wiring techniques to ensure that cross connections do not occur between the termination resistors, biasing resistors and shield wires.

12. Controller Loading on an RS-485 network:

- a. The contractor shall determine the transceiver unit load and the adapter circuit unit load for each device to be connected to the RS-485 network. This information shall be included with the product submittals. The controller’s unit load is the sum of the transceiver unit load and the adapter unit load. In the absence of documented data, the contractor must assign a controller unit load of 1 to a device. Note: Most data sheets only provide the transceiver unit load.
- b. The number of controller unit loads that may be installed on a segment is a function of the transceiver characteristics of all of the controllers to be installed.
 - 1) Category A: All of the devices are failsafe and isolated.
 - a) Total allowed loading is 48 unit loads
 - b) The NSC consumes 0.5 unit loads leaving 47.5 unit loads for other devices.
 - 2) Category B: All of the devices are failsafe, but one or more of the devices are non-isolated.
 - a) Total allowed loading is 32 unit loads
 - b) The NSC consumes 0.5 unit loads leaving 31.5 unit loads for other devices.
 - 3) Category C: All of the devices are isolated, but one or more of the devices are non-failsafe.
 - a) Total allowed loading is 24.5 unit loads
 - b) The NSC consumes 0.5 unit loads leaving 24 unit loads for other devices
 - 4) Category D: One or more of the devices are non-failsafe and one or more of the devices are non-isolated.
 - a) Total allowed loading is 8.5 unit loads.
 - b) The NSC consumes 0.5 unit loads leaving 8 unit loads for other devices.

13. Isolated Transceiver Devices and the Shield Wire:

- a. Unless otherwise directed by a product vendor, when RS-485 controllers with isolated transceivers are installed, the shield shall be connected to the "Reference" terminal on each controller with an isolated transceiver.
 - b. This connection provides an earth ground reference to the isolated device.
14. Server Limitations for RS-485 Devices:
 - a. The above limitations are derived from the electrical characteristics of RS-485 communications.
 - b. System vendors may impose more stringent limitations on the number of RS-485 devices that can be supported by a Network Server Controller or Enterprise Server.
 - c. The contractor must ensure that system vendor limitations are not exceeded. Under no circumstances shall the installation exceed the limitations based on RS-485 electrical characteristics.

2.3 NETWORK SERVER CONTROLLERS (NSC)

A. Physical Characteristics:

1. Network Server Controllers shall combine routing functions, control functions and server functions in a single integral unit.
2. LAN/WAN: The NSC shall connect to the Owner's LAN/Wan and support communication speeds up to 100 megabits per second.
3. LON Field Bus: The NSC shall connect to a twisted pair FT-10A Lon field bus at 78 kilobits per second.
4. RS-485: The NSC shall have two or more RS-485 ports for the connection of shielded twisted pair cable. Communication speed shall be adjustable between 9600 bits per second and 76.8 kilobits per seconds.
5. INET: The NSC shall have the ability to connect to an INET RS-485 Controller LAN operating at 19.2 kilobits per second. This is in addition to the two RS-485 ports.
6. Physical IO: By a dedicated physical connection, the NSC shall support the capability to attach multiple physical point expansion modules to allow the NSC to operate as a programmable process controller.
 - a. It shall be possible to install IO modules that combine specific point types in order to meet control requirements.
 - b. Point Count: The total allowed point count for the IO modules shall not exceed 120.
 - c. It shall be possible to replace a specific IO module with a new IO module of the same type without any engineering effort. The new IO module shall automatically begin operation.
 - d. All digital outputs shall include integral (not add on) three position manual override switches to allow selection of the ON, OFF, or AUTO mode of operation. The status of these override switches shall automatically be available to the system database.
 - e. All analog outputs shall include integral (not add on) two position manual override switches to allow selection of the MANUAL or AUTO mode of operation and override potentiometers to allow a manually set output voltage when the override switch is in the MANUAL mode.

- f. Temperature sensors supported by universal inputs on the physical IO modules shall include the following types.
 - 1) 10KOhm Type I (Continuum)
 - 2) 10KOhm Type II (Inet)
 - 3) 10KOhm Type III (Satchwell)
 - 4) 10KOhm Type IV (FD)
 - 5) Linearized 10KOhm Type V (FD with 11KOhm shunt)
 - 6) Linearized 10KOhm (Satchwell)
 - 7) Linearized 1.8KOhm (Xenta)
 - 8) 1 KOhm (Balco)
 - 9) 20 KOhm (Honeywell)
 - 10) 2.2 KOhm (Johnson)
- g. The following sensor types shall be supported by IO modules specifically designed to support RTD inputs. Universal inputs do not have to support these types of sensors.
 - 1) PT100 Common Industry RTD Sensor
 - 2) PT1000 Common Industry RTD Sensor
 - 3) Ni1000 Sauter RTD Sensor
 - 4) Siemons LG-Ni1000 RTF Sensor
- h. RTD Sensor Inputs shall support both two wire and three wire installation techniques.
 - 1) The input and output circuits must meet the requirements defined for programmable process controllers.
- i. Configuration Cable: The NSC shall have a cable port to provide connectivity to a laptop USB port for assigning the IP address and changing the firmware.
- j. Power Supply: The NSC shall be provided with a custom power supply unit to power the NSC and the physical point expansion modules. The power supply unit shall use 24 VAC in either full wave or half wave configuration and create 30 Watts of power at 24 VDC for the NSC and IO modules. When the total load of the NSC and IO modules exceeds 30 Watts, a second power supply may be installed in series with the IO modules to provide additional power.
- k. LEDs: The NSC shall have LED indication for CPU status, Ethernet LAN status and field bus status.
- l. Real Time Clock: The NSC shall have a real time clock with battery backup accurate to 10 seconds per day.
 - 1) Information provided shall include time of day, day, month, year and day of week.
 - 2) The UTC offset shall be adjustable to establish a specific time zone for the NSC.
 - 3) Standard or custom daylight saving time configuration shall be possible.

- m. FLASH Memory Storage: The operating system of the NSC, application programs and all other portions of the database shall be stored in non-volatile, FLASH memory.
- n. Free Memory: With the system in full operation, the NSCs shall have 20% free memory.
- o. Device Memory: The NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for the storage of a backup file.

B. Performance

- 1. Restoration After Power Outage: Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on the current synchronized time and status and implement special start-up strategies as programmed.
- 2. Battery Backup: The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupt or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.
- 3. FLASH Memory: The operating system of the NSC, application programs and all other configurable database objects such as graphics, trends, alarms, views etc. shall be stored in non-volatile FLASH memory.
- 4. Applications in the Network Server Controllers shall monitor the Network Server Controller input points and control the Network Server Controller output points.
- 5. Applications in the Network Server controllers shall monitor data from field bus controllers, execute applications using that data and send commands and/or parameters to field bus controllers.
- 6. Control Programs: Control programs shall be freely programmable by an application engineer from a defined mathematical tool set. Multiple programs shall process in parallel with all programs executing simultaneously. Any program may affect the operation of any other program via data flow from program to program. Each program shall have the full access of all IO facilities of the processor. The execution of control functions shall not be interrupted due to normal user communications including interrogation, program entry, printing or saving. The scan rate for control programs shall be adjustable and must include settings of 0.5 seconds, 1.0 second, 5 seconds and 10 seconds.
- 7. The Network Server Controller shall host graphics, trend logs, charts, alarm views and other similar presentation objects that can be served to operator workstations or web-based operator workstations.
- 8. The Network Server Controller shall be capable of executing the following functions:
 - a. Calendar based time schedules
 - b. Recurring time based schedules
 - c. Holiday based schedules
 - d. Trending based on adjustable time intervals
 - e. Trending based on change of state or value
 - f. Alarm condition monitoring
 - g. Alarm message routing
 - h. Time synchronization by means of an Internet site including automatic synchronization

- i. Native integration of data from LON field bus controllers
 - j. Native integration of BACnet data from BACnet field bus controllers
 - k. Native integration of Modbus data from Modbus field bus controllers
 - l. Native integration BACnet data from BACnet IP devices
 - m. Native integration of Modbus data from Modbus IP devices
 - n. Native integration of data from IP devices using Web Services.
9. The Network Server Controller shall execute LonWorks Network Management functions.
- a. Assign domain number, subnet numbers and node numbers to LON field bus controllers.
 - b. Establish LON bindings between the Network Server Controller and LON field bus controllers.
 - c. Establish LON bindings between two field bus controllers.
 - d. Assign a Binding Service type to all LON bindings.
- C. User Programming Language
- 1. Control programs in the Network Server Controller shall be user programmable. An application engineer shall be able to create multiple programs to meet specified control sequences.
 - 2. Output data from one program shall be able to be input data to a second program.
 - 3. The Network Server Controller shall support the use of a script-based structured text application programming tool and a graphical object oriented application programming tool.
 - 4. The application engineer shall be able to add comments anywhere in the body of either script or graphical function block programs.
 - 5. Inputs to programs shall include:
 - a. Status of physical input points
 - b. Values from the database
 - c. Status of time schedules
 - d. User adjustable parameters
 - 6. Outputs from the programs shall include
 - a. Commands to physical output points
 - b. Data to Software Points in the database
 - 7. The values of inputs and outputs to programs shall be viewable by the operator.
 - 8. It shall be possible to create viewable values within the programs. As an example, a program may have multiple room temperatures as inputs. The program calculates the average temperature and uses the average temperature within the program as part of an algorithm to create an output from the program. It shall be possible for the operator to view the average temperature value.
 - 9. The following algorithms shall be integral to the application programming software.
 - a. Proportional, Integral plus Derivative Control
 - 1) Ziegler Nichols model

- 2) Velocity Form of the PID Model
- b. Two position control with hysteresis (deadband)
 - 1) Direct acting
 - 2) Reverse acting
- c. Digital Filtering
- d. Rolling Average Analog Filtering for stability
- e. Ratio Calculations (Reset Schedule) with output limit control
- f. Time Delay On
- g. Time Delay Off
- h. Mathematical limits
- i. Sample and hold
- j. Latching with reset
- k. Minimum On Time
- l. Minimum Off Time
- m. Curve fitting with up to 64 points on the curve
- n. Horner Scheme Polynomial function with support for up to 64 coefficients
- o. Enthalpy function supporting imperial units
- p. Time functions (second, minute, hour, day of week, day of month)
- q. Integration
- r. Runtime
- s. Timed pulses
- t. Basic mathematical functions (addition, subtraction, multiplication, division, powers, square root, logarithms, Boolean logic, greater than, less than, equal to, exclusive or, if-then-else, etc.)
- u. Mathematical expressions shall support nesting of parentheses five levels deep.

D. Energy Management Routines

- 1. With standard database objects and application programs, the following energy management routines shall be supported.
 - a. Time of Day Scheduling
 - b. Calendar Based Scheduling
 - c. Holiday Scheduling
 - d. Temporary Schedule Overrides
 - e. Optimal Start
 - f. Optimal Stop
 - g. Night Setback Control
 - h. Night Setup Control
 - i. Unoccupied Purge Mode
 - j. Peak Demand Limiting
 - k. Temperature Compensated Duty Cycling
 - l. CFM Tracking for Dual Fan VAV Systems
 - m. Static Pressure Set Point Reset as a function of VAV terminal unit performance
 - n. Supply Air Temperature Set Point Reset as a function of VAV terminal unit performance
 - o. Water (Hydronic) flow reset as a function of system differential pressure.

E. Historical Data Logging (Trend Logs)

1. A trend log is defined as the original logging of an element of data over time based on a fixed time interval or a change of value or state.
2. An extended trend log is defined as a log at a higher level in the system architecture where the log data from a trend log or lower level extended trend log is periodically transferred. Extended trend logs will have a larger number of records allowed for long term data storage.
3. Logging Concepts
 - a. A field bus controller supports logging. A trend log exists in a field bus controller. An extended trend log exists in the Network Server Controller and the trend log data from the field bus controller is periodically uploaded. An extended trend log exists in the Enterprise Server (Computer) and the trend log data from the extended trend log in the Network Server Controller is periodically uploaded.
 - b. A field bus controller does not support logging. Data from the field bus controller is mirrored in the Network Server Controller. A trend log is established in the Network Server Controller to trend the mirrored data. An extended trend log exists in the Enterprise Server (Computer) and the trend log data in the Network Server Controller is periodically uploaded.
 - c. Data in a field bus controller may be directly trended by the Network Server Controller bypassing the mirrored data concept provided that the type of trend logging is time based and the time interval is ten minutes or greater. The contractor must ensure that the use of this concept does not create excessive bandwidth utilization due to a large number of variables being trended. For a Lon field bus, an average bandwidth utilization of 30% is considered excessive.
4. Logging Criteria
 - a. Time intervals of 1 second to 1440 seconds must be supported.
 - b. For change of value trend logs, the delta must be adjustable.
 - c. The raw logged data must be instantaneous. The presentation of the data must include the following automatic calculations to the raw data.
 - 1) Maximum
 - 2) Minimum
 - 3) Average
 - 4) Sum
 - 5) Delta
 - 6) Meter Consumption (for meter logs)
5. With respect to Trend Logs, the Network Server Controller shall support:
 - a. 1,000 trend logs
 - b. 1,500 extended logs
 - c. 100,000 records for a trend log
 - d. 600,000 records for an extended log
 - e. 3,800,000 total log records (trend logs and extended logs)

6. Transferring logged data from a lower level in the architecture to a higher level in the architecture shall be based on one of the following. All options must be available to the operator.
 - a. Manual command to upload
 - b. Defined time period
 - c. Percentage of logged space filled
7. Trends shall be set up by the contractor for all temperature & set points, valve command/feedback, any enable/status, speed/feedback, damper positions and any other data points that are pertinent to troubleshooting.

F. Historical Data Presentation (Trend Charts and Trend Lists)

1. Trend charting capability shall exist in the Network Server Controllers and the Enterprise Server.
2. Trend list capability shall exist in the Network Server Controllers and the Enterprise Server.
3. Trend lists shall display data in a time stamped list format.
4. Trend charts shall support configurable pen colors, configurable line weights, two adjustable scales and adjustable time spans.

G. Alarm Management

1. Alarm objects shall monitor data that exists in the Network Server Controller or the Enterprise Server. If the data that needs to be monitored exists in a field bus controller, the data shall be mirrored in the Network Server Controller, using event driven factors such as send on delta (COV), minimum send time and maximum send time to manage bandwidth utilization. The alarm object shall then monitor the mirrored data.
2. Types of Alarm Monitoring
 - a. Monitored data changes state
 - b. Monitored data matches a specific integer
 - c. Monitored data is outside of a specific range of value, either above or below
 - d. Monitored data is not within a specified range of a second monitored value, either above or below
 - e. Monitored data text string does not match a specified text string
 - f. Sum Alarms: Multiple alarm conditions must be met
3. Data Monitoring by Alarm Objects
 - a. Data in the Network Server Controllers or the Enterprise Server shall be monitored no less than twice a second.
4. Alarm messages shall be presented to the users in a fully configurable order, by priority, by time, by category, etc. These configurable alarm lists shall be presented to the user upon logging into the system from either the Workstation or a Web Browser.
5. The alarm management shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When

acknowledging an alarm, it shall be possible to assign it to a specific user of the system such that the specific user is notified of the assignment and is made responsible for the alarm resolution.

6. Alarm Objects in Field Bus Controllers may be used if they are compatible with the workstation alarm management system and there is no loss of capability.

H. Embedded Web Server

1. Each Network Server Controller shall have the ability to serve out web pages containing the same information that is available from the Workstation presentation. The development of the screens to accomplish this shall not require any additional engineering labor over that required to show them via the Workstation presentation.

I. Network Server Controller Configuration

1. Configuration shall be possible without the use of an operable IP network via a cross over cable.
2. Optionally a direct connect proprietary cable may be used to assign an initial IP address and load firmware.
3. Once a Network Server Controller has an IP address that is compatible with the IP network and the IP network is operational, configuration shall be possible via the IP network.

J. Network Server Controller to Network Server Controller Communication

1. A Network Server Controller shall have the ability to poll for data from a second Network Server Controller.
 - a. The polling rate shall be adjustable at 1 second, 5 seconds or 10 seconds.
2. A Network Server Controller shall be able to request data from up to ten other Network Server Controllers.
3. A Network Server Controller shall be able to respond to requests for data from up to 64 other Network Server Controllers.
4. Data being transferred from Network Server Controller to Network Server Controller shall be positioned as values in the Network Server Controller database.
 - a. Data that originates in a Lon field bus controller shall be transferred to its hosting Network Server Controller via a Lon binding to a Lon network variable on the Network Server Controller.
 - b. This data shall then be transferred to a value in the Network Server Controller for subsequent transfer to a second Network Server Controller.

K. Supervisory Logic Support for Field Bus Controllers

1. The Network Server Controller shall provide supervisory logic support for the Lon field bus controllers on its sub-ordinate FT-10A Lon field bus.
2. Data required as input to supervisory logic shall be transferred to the Network Server Controller via a Lon binding to a Lon network variable on the Network Server Controller.
3. Application programs in the Network Server Controller shall read the transferred values, execute the programmed algorithms and send commands and values to outbound network variables on the Network Server Controller.

4. These outbound network variables shall then be transferred to the Lon field bus controllers via Lon bindings.
5. Appropriate values for send on delta, min send time and max send time parameters shall be used to maintain reasonable bandwidth utilization (Average Bandwidth Utilization Less Than 30%).

L. Time Based Control for Applications in Field Bus Controllers

1. Time schedules, standard and optimized, shall reside in the Network Server Controllers.
2. Occupancy commands shall be sent to an outbound network variable on the Network Server Controller.
3. The outbound network variables shall then be transferred to the Lon field bus controllers via Lon bindings.

2.4 PHYSICAL LAYER REPEATERS (PLR)

- A. PLRs are required to connect two segments of the FT-10A field bus.
- B. The design of the PLRs shall conform to LonMark Standards.
- C. Lon to Lon routers configured as repeaters may be used to perform as a PLR. If configuration of the Lon to Lon router requires a third party configuration tool such as LonMaker for Windows or NL220, then the Lon to Lon router may not be used. The configuration of the device must be via on-board dip switches.

2.5 LON TO LON ROUTERS

- A. Lon to Lon routers may be used to add a second channel to the FT-10A field bus.
- B. The field bus architecture shall be designed such that any field bus controller has a maximum of one Lon to Lon router between it and the Network Server Controller.
- C. Lon to Lon routers must operate in a Learning mode and not require commissioning by a third party network management tool such as LonMaker for Windows or NL220. Configuration as a Learning Router shall not require any software tool.

2.6 LON FIELD BUS DEVICES

A. General Requirements

1. Devices shall incorporate a service pin which, when pressed, will cause the device to broadcast its 48 bit node ID and its program ID over the network. The service pin shall be distinguishable and accessible.
2. Devices shall have a light indicating that they are powered.
3. Devices shall incorporate a TP/FT-10A transceiver in accordance with ANSI/EIA 709.3 and connections for TP/FT control network wiring.
4. Devices shall be locally powered. Link powered devices are not acceptable.
5. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings.

B. Programmable Process Controller (PPC)

1. The key characteristics of a PPC are:
 - a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices and binary output devices. The number and type of input and output devices supported will vary by model.
 - b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O may be by additional circuit boards that physically connect to the basic controller or by a stand-alone device that communicates with the basic controller via the FTT-10A field bus.
 - c. The application to be executed by a PPC is created by an application engineer using the vendor's application programming tool.
 - d. PPCs shall support embedded time schedules for use when the controller has lost communication with the NSC. The Network Server Controller will provide time schedule support for the PPC applications.
 - e. PPCs shall support trend data storage with periodic upload to extended trend logs in the NSC. Trend logging for up to 50 variables shall be supported.
 - f. PPCs shall support the initiation of an alarm message to the NSC
2. Analog Input Circuits
 - a. The electrical signals from analog sensors shall be processed by an analog to digital (A/D) converter chip. The output of the A/D chip shall then be processed mathematically to produce data within the controller that has the required engineering units.
 - b. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
 - c. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
 - d. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
 - e. For non-linear sensors such as thermistors and flow sensors the PPC shall provide software support for the linearization of the input signal.
3. Digital Outputs
 - a. All digital outputs shall have a status (feedback) input directly related to the respective output.
 - b. Each feedback shall be graphically displayed on the appropriate graphics page(s).
4. Binary Input Circuits

- a. Dry contact sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
5. Pulse Input Circuits
- a. Pulse input sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
 - c. The pulse input circuit shall be able to process up to 50 pulses per second.
6. True Analog Output Circuits
- a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
 - b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
7. Pulse Width Modulation Outputs with PWM transducers
- a. The controller shall be able to generate incremental pulses as small as 0.1 seconds.
8. Binary Output Circuits
- a. Single pole single throw or single pole double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
 - b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.8 amps.
9. Application Programming Software
- a. Application programming shall be accomplished using a graphical object oriented tool.
 - b. The following algorithms shall be integral to the application programming software.
 - 1) Proportional, Integral plus Derivative Control
 - a) Ziegler Nichols model
 - b) Velocity Form of the PID Model
 - 2) Two position control with hysteresis (deadband)
 - a) Direct acting
 - b) Reverse acting
 - 3) Digital Filtering
 - 4) Rolling Average Analog Filtering for stability
 - 5) Ratio Calculations (Reset Schedule) with output limit control
 - 6) Time Delay On

- 7) Time Delay Off
- 8) Mathematical limits
- 9) Sample and hold
- 10) Latching with reset
- 11) Minimum On Time
- 12) Minimum Off Time
- 13) Curve fitting with up to 64 points on the curve
- 14) Horner Scheme Polynomial function with support for up to 64 coefficients
- 15) Enthalpy function supporting imperial units
- 16) Time functions (second, minute, hour, day of week, day of month)
- 17) Integration
- 18) Runtime
- 19) Timed pulses
- 20) Basic mathematical functions (addition, subtraction, multiplication, division, powers, square root, logarithms, Boolean logic, greater than, less than, equal to, exclusive or, if-then-else, etc.)
- 21) Mathematical expressions shall support nesting of parentheses five levels deep.

10. Program Execution

- a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
 - b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
 - c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
 - d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
 - e. The application shall have the ability to determine if a power cycle to the controller has occurred, and the application programmer shall be able to use the indication of a power cycle to modify the sequence of control immediately following a power cycle.
 - f. Local Interface: The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
 - 1) Adjust application parameters.
 - 2) Edit time schedule parameters if time schedules are embedded in the controller.
 - 3) Execute manual control of input and output points.
 - 4) View dynamic data.
 - 5) View alarm messages if alarm messaging is embedded in the controller.
11. Each PPC shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.

C. Supervisory Logic Controller (SLC)

1. Supervisory logic shall be located in the Network Server Controller unless special application requirements require the use of a SLC. If SLCs are required, the following requirements apply.
2. The key characteristics of an SLC are:
 - a. The application to be executed by as SLC is created by an application engineer using the vendor's application programming tool.
 - b. SLCs shall support embedded time schedules for use when the controller loses communication with the NSC.
 - c. SLCs shall support trend data storage with periodic upload to extended trend logs in the NSC. Trend logs for up to 50 variables shall be supported.
3. Application Programming Software
 - a. The requirements for the application programming tool used to create applications in a SLC are identical to those described for a Programmable Process Controller.
4. SLCs shall support the initiation of an alarm message to the NSC.
5. Program Execution
 - a. Control algorithms shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
 - b. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
 - c. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of control immediately following a power cycle.
6. Local Interface: The controller shall support the connection of a interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
 - a. Adjust application parameters.
 - b. Edit time schedule parameters if time schedules are embedded in the controller.
 - c. Execute manual control of input and output network variables.
 - d. View dynamic data.
 - e. View alarm messages if alarm messaging is embedded in the controller.
7. Each SLC shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.
8. Supervisory logic controllers shall have support a minimum of 200 input network variables and 70 output network variables.
 - a. The SNVT for each of the 200 input network variables shall be selectable.
 - b. The SNVT for each of the 70 output network variables shall be selectable.

- c. For the input and output network variables there shall not be any limitations as to the SNVT selected. (Example: SNVT_temp_p can only be used on 10 input network variables.)
9. Application Specific Devices (ASD)
- a. ASD shall have fixed function configurable applications.
 - b. If the application can be altered by the vendor's application programming tool, the device is a programmable controller and not an application specific device. A
 - c. All input and output network variables shall be formatted with SNVTs.
 - d. All input configuration parameters shall be formatted with SNVTs or SCPTs. If UNVTs or UCPTs are used, the device resource files that allow these custom parameters to be read shall be provided to the owner.
 - e. The network interface shall conform to the LonMark profile for the application provided by the ASD.
 - f. Each ASD shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.

2.7 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors

- 1. Known acceptable source: Veris Industries
- 2. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of -30 to 230 degrees F. Space temperature sensors shall be accurate to +/-0.5 degrees F over a range of 40 to 100 degrees F.
- 3. Room Sensor: Standard space sensors shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series.
 - a. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
 - b. Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
- 4. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series.
- 5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series.
- 6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a

corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series.

7. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 Deg. F, Basis of Design: Veris TO Series.
8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Wall Transmitters

1. Known acceptable source: Veris Industries.
2. Transmitters shall be accurate to +/- 1 % at full scale.
3. Transmitter shall have replaceable sensing element.
4. Sensor type shall be thin-film capacitive.
5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory.
6. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F.
7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
9. Transmitter shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box.
10. Transmitter shall have LCD display.
11. Transmitter shall be available with a certification of NIST calibration.
12. Transmitter shall have integrated temperature sensor.
13. Basis of Design: Veris HWL Series.

C. Humidity Duct Transmitters

1. Know acceptable source: Veris Industries.
2. Transmitters shall be accurate to +/- 2 % at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory.
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F.
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall be available with a certification of NIST calibration.
11. Transmitter shall have integrated temperature sensor.
12. Basis of Design: Veris HD Series.

D. Humidity Outdoor Transmitters

1. Known acceptable source: Veris Industries.
2. Transmitters shall be accurate to +/- 2% at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.

6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory.
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 Deg. F.
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall be available with a certification of NIST calibration.
11. Transmitter shall have integrated temperature sensor.
12. Basis of Design: Veris HO Series.

E. Air Pressure Transmitters

1. Known acceptable source: Veris Industries.
2. Sensor shall be microprocessor profiled ceramic capacitive sensing element.
3. Transmitter shall have 14 selectable ranges from 0.1 – 10" WC.
4. Transmitter shall be +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Transmitter shall be field configurable to mount on wall or duct with static probe.
6. Transmitter shall be field selectable for Unidirectional or Bidirectional.
7. Maximum operating pressure shall be 200% of design pressure.
8. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Response time shall be field selectable T95 in 20 seconds or T95 in 2 seconds.
11. Transmitter shall have an LCD display.
12. Units shall be field selectable for WC or PA.
13. Transmitter shall have provision for zeroing by pushbutton or digital input.
14. Transmitter shall be available with a certification of NIST calibration.
15. Basis of Design: Veris model PXU.

F. Liquid Differential Pressure Transmitters

1. Known acceptable source: Veris Industries.
2. Transmitter shall be microprocessor based.
3. Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure.
4. Transmitter shall have 4 switch selectable ranges.
5. Transmitter shall have test mode to produce full-scale output automatically.
6. Transmitter shall have provision for zeroing by pushbutton or digital input.
7. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
8. Transmitter shall have field selectable electronic surge damping.
9. Transmitter shall have an electronic port swap feature.
10. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
11. Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.
12. Performance:
 - a. Accuracy shall be $\pm 1\%$ F.S. and $\pm 2\%$ F.S. for lowest selectable range.
 - b. Long term stability shall be $\pm 0.25\%$.
 - c. Sensor temperature operating range shall be -4° to 185°F.
 - d. Operating environment shall be 14° to 131°F; 10-90% RH noncondensing.
 - e. Proof pressure shall be 2x max. F.S. range.
 - f. Burst pressure shall be 5x max. F.S. range.

13. Transmitter shall be encased in a NEMA 4 enclosure.
14. Enclosure shall be white powder-coated aluminum.
15. Transmitter shall be available with a certification of NIST calibration.
16. Basis of Design: Veris PW.

G. Current Sensors

1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer either a digital or an analog signal to the automation system. Known acceptable source is Veris Industries.

H. Current Status Switches for Constant Load Devices

1. Known acceptable source: Veris Industries.
2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
3. Visual LED indicator for status.
4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
5. Normally open current sensor output. 0.1A at 30 VAC/DC.
6. Basis of Design: Veris Model H608.

I. Current Status Switches for Constant Load Devices (Auto Calibration)

1. Know acceptable source: Veris Industries.
2. General: Microprocessor based, self-learning, self-calibrating current switch. Calibration-free status for both under and overcurrent, LCD display, and slide-switch selectable trip point limits. At initial power-up automatically learns average current on the line with no action required by the installer.
3. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 200 A.
4. Display: Backlit LCD; illuminates when monitored current exceeds 4.5A.
5. Nominal Trip Point: $\pm 40\%$, $\pm 60\%$, or on/off (user selectable).
6. Normally open current sensor output. 0.1A at 30 VAC/DC.
7. Basis of Design: Veris Model H11D.

J. Current Status Switches for Variable Frequency Drive Application

1. Known acceptable source: Veris Industries.
2. General: Microprocessor controlled, self-learning, self-calibrating current sensor to detect motor undercurrent and overcurrent situations such as belt loss, coupling shear, and mechanical failure on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory and relearn.
3. Visual LED indicator for status.
4. Alarm Limits: $\pm 20\%$ of learned current in every 5 Hz freq. band.
5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 1.5 A to 150 A and from 12 to 115 Hz.
6. Normally open current sensor output. 0.1A at 30 VAC/DC.
7. Basis of Design: Veris Model H614.

K. Liquid Flow, Insertion Type Turbine Flowmeter

1. Known acceptable source: Veris Industries.
2. General: Turbine-type insertion flow meter designed for use in pipe sizes 1 1/2" and greater. Available in hot tap configuration with isolation valves and mounting hardware to install or remove the sensor from pipeline that is difficult to shut down or drain.
3. Performance:
 - a. Accuracy: $\pm 1\%$ of rate over optimum flow range; ≥ 10 upstream and ≥ 5 downstream straight pipe diameters, uninterrupted flow.
 - b. Repeatability: $\pm 0.5\%$.
 - c. Velocity Range: 0.3 to 20 FPS.
 - d. Pressure Drop: 0.5 psi or less @ 10 ft/sec for all pipe sizes 1.5" diameter and up.
 - e. Pressure Rating: 1000 psi @ 70°F.
4. Maximum Temperature Rating: 300°F.
5. Materials: Stainless Steel or Brass body; Stainless steel impeller.
6. Transmitter:
 - a. Power Supply: 12 - 30VAC or 8 - 35VDC.
 - 1) Output: Frequency, 4-20 mA or Scaled Pulse.
 - b. Temperature Range: 14° to 150°F.
 - c. Enclosure: NEMA 4, Polypropylene with Viton® sealed acrylic cover.
7. Basis of Design: Veris SDI series.

L. Control Valves

1. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves which mate and match the material of the connected piping. Equipment control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve required leakage specification.
2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.
3. All control/bypass valves shall be Belimo Energy Valves and shall meet the following:
 - a. Pressure independent control valves (Water Coil Optimization).
 - b. NPS 2" and smaller: Forged brass body rated at no less than 250 psi, stainless steel ball and stem female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.
 - c. NPS 2-1/2" through 6": GG25 cast iron body according to ANSI Class 125, Standard Class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
 - d. Accuracy: Control valves shall accurately control the flow from 0 to 100% of the rated flow with an operating pressure differential range of 5 to 50 psi differential

across the valve with a valve body flow accuracy of ± 5 total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.

- e. Flow Characteristics: Equal percentage characteristic.
 - f. All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
 - g. Water coil optimization shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet and outlet water temperatures; and an electronic flow meter to provide analog flow feedback. Software shall control the valve to avoid the coil differential temperature from falling below a programmed set point, the valve assembly shall be capable of accepting an analog signal representing the coil power required. Real-time data and configuration of valve operating parameters shall be available by means of BACnet MS/TP, BACnet/IP or HTTP. Monitored points shall include, but not be limited to inlet and outlet coil water temperatures, absolute flow, absolute valve position, absolute coil power and total heating/cooling energy in BTU/hr. Configuration points shall include but not be limited to valve, flow, and power settings. Historical trend data shall be stored for up to 13 months and be retrievable in a standard time-stamped format.
 - h. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).
 - i. A wet calibrated electronic flow meter shall provide dynamic feedback to measure flow and verify performance.
 - j. The control valve shall require no maintenance and shall not include replaceable cartridges.
 - k. Known Acceptable Source: Belimo EV050s-055=LRX24-EV.
4. Electric actuation should be provided on all terminal unit reheat applications unless electric heat is provided.

M. Damper Actuators

- 1. Damper actuators shall be electronic, and shall be direct coupled over the shaft, without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.

N. Actuators (General)

- 1. All actuators (dampers, valves, etc.) shall have dual status switches.
- 2. Known Acceptable Source: Belimo AFB24-S.

O. Smoke Detectors

1. Air duct smoke detectors shall be provided by the fire alarm contractor. Detectors shall be installed by the mechanical contractor and wired by the electrical contractor.
2. Controls contractor shall provide an auxiliary alarm status point connection to the DDC system.

P. Airflow Measuring Stations

1. Provide a thermal anemometer using instrument grade self –heated thermistor sensors with thermistor temperature sensors.
2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

2.8 ENTERPRISE SERVER HARDWARE

A. Processor

1. Minimum of 2.0 GHz
2. Recommended at 2.6 GHz or higher.

B. Memory

1. Minimum of 4 GB
2. Recommended at 4 GB or higher

C. Operating System shall conform to system vendor requirements. When the vendor supports multiple systems, the most current system shall be used:

1. Microsoft Windows 7 Pro 32-bit, or
2. Microsoft Windows 7 Pro 64-bit, or
3. Microsoft Windows 8.1, most current

D. 10/100 MBPS Ethernet NIC

E. 250 GB Hard Disk as a minimum

F. Read/Write DVD Drive

G. License agreement for all applicable software

H. Third Party Software: All third party software required for a fully operational system shall be provided and licensed. Example: Microsoft Office

2.9 WORKSTATION HARDWARE AND SYSTEM SOFTWARE

A. Processor

1. Minimum of 2.0 GHz
2. Recommended at 2.0 GHz or higher

B. Memory

1. Minimum of 4 GB
2. Recommended at 4 GB or higher

C. Operating System shall conform to system vendor requirements. When the vendor supports multiple systems, the most current system shall be used:

1. Microsoft Windows 7 Pro 32-bit, or
2. Microsoft Windows 7 Pro 64-bit, or
3. Microsoft Windows 8.1, most current

D. 10/100 MBPS Ethernet NIC

E. 250 GB Hard Disk as a minimum

F. Read/Write DVD Drive

G. License agreement for all applicable software

H. Third Party Software: All third party software required for a fully operational system shall be provided and licensed. Example: Microsoft Office

2.10 WEB-BASED OPERATOR WORKSTATION HARDWARE AND SYSTEM SOFTWARE

A. Any user on the network shall be able to access the Enterprise Server or any NSC by using the following software:

1. Windows XP or Windows 7 Operating System
2. Google Chrome
3. Firefox 4.0, 32-bit and above
4. Internet Explorer 10, 32-bit and above

2.11 WORKSTATION/SERVER REQUIREMENTS

A. General

1. Provide one (1) Enterprise Server.
 - a. Provide access for 10 web based operators and 2 workstation based engineering/operator users concurrently
2. Provide one (1) Operator Work Station

B. Databases

1. The Enterprise Server and Network Server Controllers shall hold the databases.
2. When an operator connects to the Enterprise Server, all databases shall be accessible (the ES database and one Db for each NSC).

3. When an operator connects to a specific NSC, only the database in that NSC shall be accessible.
 4. The workstation software shall allow any user with adequate permission to create and/or modify any or all parts of a database. These changes are recorded within the databases and not on the operator workstation. When two operators are connected to a database, a change made by one operator will automatically be viewable by the second operator.
- C. Workstation Software shall include as a minimum:
1. Programming editors
 2. Configuration editors
 3. Graphics creation editor
 4. Object creation editors (points, values, folders, programs, charts, lists, views, bindings, etc.)
 5. Alarm viewing
 6. Event viewing
 7. Trend data presentation
 8. Graphics viewing
- D. General Administration and Programming Workstation Software
1. The system architecture shall be client server in that the Workstation shall operate as the client while the ES or NSC shall operate as the servers. The server is responsible for data gathering, data storage and data delivery to clients. The client is responsible for data presentation to the user and delivery of user instructions to the server databases.
 2. Workstation functions shall include:
 - a. Monitoring data from the ES, NSCs and Field Bus Controllers
 - b. Programming the ES database, the NSC databases and the Field Bus Controller applications.
 - c. Configuring Application Specific Devices
 - d. Viewing and managing alarms
 - e. Viewing and managing events
 - f. Viewing graphic displays
 - g. Viewing collected data (trend logs, extended logs)
 - h. Schedule and set point adjustments
 - i. Executing operator overrides of applications
 3. Programmable Field Bus Controllers
 - a. The engineer shall be able to program a PPC either off-line or on-line.
 - b. All data from the PPCs shall be available in graphic or text displays in the NSC.
 4. Graphic displays will:
 - a. Feature animation effects to indicate the status or values associated with systems.
 - b. Alert operators of problems.
 - c. Facilitate location of information throughout the system.
 5. Operator Interaction
 - a. All operator functions shall be selectable through the use of a mouse to the maximum extent possible.

E. User Interface

1. The workstation software shall allow the creation of a custom, browser-style interface linked to each individual user that logs into the system.
2. It shall be possible to create customized workspaces that can be assigned to a specific collection of users (user groups).
3. The user interface will support the creation of hot spots or links to all objects or software tools that are appropriate for the given user. This interface will be the user's "PC Desktop".
4. The system administrator shall be able to limit what a specific user can see or do with respect to the workstation and the database.
 - a. A user that is not associated with a central system might not be given rights to access the system data or see the alarms associated with the system.
 - b. A user might be given rights to view data but not control data for specific portions of the database.
5. The BAS system shall automatically use the units (SI or Imperial) that are associated with the regional setting of the PC.

F. User Security

1. The software shall provide for each user to have a unique username and password.
2. The software shall provide that a collection of users may be assigned to a user group that will be assigned identical capabilities within the system.
3. Users and User Groups shall be linked to a set of capabilities with the software, set by and editable only by, a system administrator.
4. The sets of capabilities shall range from View Only, Acknowledge Alarms, Enable/Disable, Change Values, Edit Programs and Administer.
5. The system shall allow the range of capabilities to be applied to each class of database object.
6. The capacity of the system must allow for up to 256 Users or User Groups to be established.
7. The system shall provide the ability to add or remove users based on Microsoft Windows Security Domains such that the customer IT department can assist in controlling user access.

G. Configuration Interface

1. The workstation software shall use a Windows Explorer style interface for an operator or engineer to view and/or edit any database object in the entire system.
2. The NSCs and Field Bus Controllers shall be presented in an organized tree structure. With each NSC or Field Bus Controller, the related points, programs, alarms, trends, charts shall be included for easy identification of the relationship of the objects to the controller.
3. All object names shall be alphanumeric and use Windows long filename conventions.
4. The tree structure shall support the use of folders to organize database objects by type or system.

5. It shall be possible to export individual objects, devices or a collection of objects creating a “library” that can then be imported for redundant use within the original database or imported in a new database.
6. The database shall support the use of copy/paste for engineering efficiency.
7. The engineer shall have the ability to mass edit a collection of like objects.
8. When one object type is created from a second object type, the engineer shall have the ability to mass create the new objects from the list of the multiple first object types.
9. The workstation shall include a search tool to create a list of objects based on specific criteria
 - a. Name
 - b. Object type
 - c. Specific Text in the Properties of the objects.

H. Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems and building layouts.
2. These graphics shall present point data from the database including any attributes associated with the point such as engineering units, forced by operator status or alarm status.
3. The operator shall be able to:
 - a. Change the value of user adjustable parameters from a graphic.
 - b. Manually control points and values from a graphic.
 - c. Move from graphic to graphic by selecting a link object on the graphic.
 - d. Move from a graphic to a trend chart by selecting a link object on the graphic.
 - e. Move from a graphic to a time schedule editor by selecting a link object on the graphic.
 - f. Move from a graphic to an alarm view by selecting a link object on the graphic.
4. Graphics should rescale based on whatever monitor or viewing device is being used.
5. Graphic expectations are symbolized with samples at the end of the specifications.

I. Graphics Editor

1. The engineer shall be able to import gif, png, bmp, jpeg, tif and CAD generated picture files as background displays, and layering shall be possible.
2. Java Script for customizing the behavior of each graphic shall be supported.
3. Scalable Vector Graphics (SVG) technology shall be supported.
4. A library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges and graphs that can be dropped onto a graphic being created shall be included with the editor. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
5. Changing screen locations, size, color, text, blinking or changing from one graphic to another graphic shall be possible based on status changes or alarm conditions in the data linked to the graphic.
6. It shall be possible to associate a specific graphic to a specific database object and launch the graphic based on specified changes in the database object.

7. Moving from one graphic to another graphic shall not require the operator to use the system database tree.
8. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable libraries.
9. It shall be possible to create graphics on varying layers that can be moved and reused.
10. It shall be possible to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, so that the pane is a single component allowing for easy changes.
11. Additional graphic editor tools shall include:
 - a. Create and save pages
 - b. Group and ungroup symbols
 - c. Modify and existing symbol
 - d. Modify and existing graphic page
 - e. Rotate and mirror a symbol
 - f. Place a symbol on a page
 - g. Place analog dynamic data on a page in decimal format
 - h. Place binary dynamic data on a page using state descriptors
 - i. Create motion through the use of animated gif files or JavaScript
 - j. Place "Forced by Operator" mode indication on a page
 - k. Place links using a fixed symbol or flyover on a page
 - l. Place links to other graphic pages on a page
 - m. Place links to web sites on a page
 - n. Place links to notes on a page
 - o. Place links to a time schedule on a page
 - p. Place links to any exe file on the operator work station
 - q. Place links to Microsoft Word files on a page
 - r. Assign a background color
 - s. Assign a foreground color
 - t. Place alarm indicators on a page
 - u. Change symbol/text/value color as a function of an analog variable value
 - v. Change a symbol/text/value color as a function of a binary state
 - w. Change a symbol/text/value as a function of a binary state
12. All symbols used by Schneider Electric Buildings Business in the creation of graphic pages shall be saved to a library file for use by the owner.

J. Automatic Data Collection

1. The software shall provide for the long term collection and storage of data from the NSCs and Field Bus Controllers.
2. The type of logging and frequency shall be user adjustable.
3. Refer to the requirements defined in the section describing the Network Server Controller.

K. Alarm Management

1. The Enterprise Server database shall include an alarm management system.

- a. The ES alarm management system shall receive all alarm messages generated by alarm objects in the ES database.
2. The Network Server Controller database shall include an alarm management system.
 - a. The NSC alarm management system shall receive all alarm messages generated by alarm objects in the NSC and any field bus controllers that are sub-ordinate to the NSC.
3. All alarms, regardless of the database location, shall appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics or reports.
4. The point of connection by the user shall determine what alarms are available to the user.
 - a. A workstation connection to the ES shall present all alarms to the user.
 - b. A workstation connection to an NSC shall present the alarms that exist in the NSC alarm management system.
5. The state of an alarm shall be a database variable.
 - a. States shall include; normal, in alarm unacknowledged, in alarm acknowledged and returned to normal without acknowledgement.
 - b. This database variable may be used to create new alarms based on alarm management criteria such as “an alarm has gone unacknowledged for more than 5 minutes”. This new alarm can then be routed to a different receiver.
6. Alarm Features:
 - a. A minimum of 1000 alarm notification levels. Each level shall have a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation and record keeping.
 - b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of the alarm, username and time of acknowledgement.
 - c. The ability to customize an active alarm viewer for each user shall be provided. What levels to display and what attributes to display shall be fully configurable.
 - d. An audible sound upon alarm initiation, and return to normal shall be configurable.
 - e. Routing of alarm messages to specific users and/or specific user groups during specific time periods and on specific days shall be configurable. The same alarm may be routed to different users and/or user groups for alternate time periods or specific days.
 - f. The font type and color and background color for each alarm notification level shall be configurable.
 - g. The active alarm viewer shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions and a drop-down list of causes for specific alarms.
 - h. The active alarm viewer shall be configurable such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.

- i. An operator shall have the ability to assign an alarm to another user of the system. Such assignments shall be tracked.
- j. The system shall have the ability to send an email alarm message or an alphanumeric pager message to specific users or user groups without a customer email client or special software interface running on the server. The system shall also support email with the customer's email client on the server.

L. Scheduling

- 1. Primary time schedules shall be located in the Network Server Controllers and stored in their local RAM.
 - a. Commands from these schedules shall be sent to applications in the NSC and in field bus controllers.
 - b. Calendars and holidays shall also be located in the NSCs.
- 2. Master Schedules (Lead Schedules), Calendars and Holidays may exist in the Enterprise Server.
 - a. These master events shall be linked to the schedules in the NSCs.
- 3. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
- 4. Schedules shall be programmable for a minimum of one year in advance.
- 5. To change a schedule for a particular day, a user shall simply select the day and make the desired changes.
- 6. Using web access, the user shall be able to view schedules as an entire year, a month, a week or a day. A simple mouse click shall change the view. Scrolling from one month to another month shall be possible.
- 7. Schedule changes made by an operator shall automatically be transmitted to the schedule object in the NSC.
- 8. The Master Schedule concept used between the ES and NSCs shall also exist within an NSC. A Master Schedule in an NSC may be associated with multiple standard schedules within the same NSC.
- 9. It shall be possible to assign one or more lists of exception event days, dates, date ranges to a schedule.
- 10. It shall be possible to view combined views showing the calendar and all prioritized exceptions on one screen.
- 11. The exception system shall accommodate a minimum of 16 priority levels.
- 12. The output of a schedule shall be bound directly to a value without the need of support from an application program.

M. Programmer's Environment

- 1. The requirements for application programming software are described under the sections on the Network Server Controller and Programmable Process Controller.
- 2. It shall be possible to save application programs in the NSC and PPC as libraries for reuse within this project and on other projects.
- 3. Reusing a library application file shall only require a simple import command.

4. Graphically programming applications in the NSC shall be viewable with live data in real time.
5. Applications in the NSC shall have configurable cycle times to allow for prioritized application execution.
6. It shall be possible to create binding templates allowing the engineer to bind multiple connections to a single object in a single set of keystrokes.
7. It shall be possible to create objects that allow common devices such as power meters, VFD drives, etc. to be integrated into the system with simple drag and drop actions without the need for complicated programming.
8. Within the line programming software tool, key terms should appear when typing (IntelliType).

N. Saving/Reloading

1. It shall be possible to copy the entire database from any server or controller and save it in a file that can be restored to the original server or controller or a new server or controller.
2. A software tool(s) shall be provided that allows an engineer to update the firmware for all servers and controllers.
3. In the ES and NSC, it shall be possible to create libraries that consist of a collection of objects within the database for reuse in this project and on other projects. All connections between the objects within the library shall be retained during the library creation process.

O. Audit Trail

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions and command for any system object individually or at least the last 5000 records of all events for the entire system.
3. It shall be possible to save custom filtered views of event information.

P. Search Function

1. It shall be possible to configure a search object that will search a defined portion of the database and present a collection of defined objects in a single list view.
2. It shall be possible to save configured search objects for reuse.

2.12 WEB BASED OPERATOR SOFTWARE

A. General:

1. Day to day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
2. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.

3. It shall not be necessary to install additional client software on the web based operator workstation.

B. Graphic Displays:

1. The browser based interface must share the same graphical displays as available via the standard workstation interface. The same information shall be presented by the graphics.
2. The browser's graphics shall support commands to change set points and enable/disable points.

C. Navigation and Actions:

1. The browser based interface shall allow the operator to navigate throughout the entire system. Changes made to any point, value or schedule shall be effective immediately with a record of the change stored in the event list.

D. Alarm Management:

1. An alarm viewer with the same information that is presented to a standard workstation user shall be available to a web user.
2. Web operators shall be able to silence alarms and acknowledge alarms.
3. The capability to add specific text to the alarm record prior acknowledgement of the alarm shall be possible.
4. Alarm attachments shall be viewable.

E. Groups and Schedules:

1. Web operators shall be able to view pre-defined groups of points with their values updated automatically.
2. Web operators shall be able to change existing time schedules.
 - a. Change start and stop times
 - b. Add new start and stop times
 - c. Modify calendars

F. User Accounts and Audit Trail:

1. The same user accounts used for standard workstation access to the system shall also function for web access. Different passwords shall not be required.
2. All user activity via web access to the system shall be recorded in the event history for the system.

2.13 WEB SERVICES

A. The ES and NSC shall support the use of the following for communication at the WAN/LAN layer of the system architecture using web services:

1. HTTP: Hyper Text Transfer Protocol
2. SOAP: Simple Object Access Protocol

- 3. XML: eXtensible Markup Language
- B. The ES and NSC shall be able to serve and consume data via web services.
- C. Customized web services shall be provided for the following:
 - 1. SmartStruxure Data Center Expert
 - 2. SmartStruxure Power Manage Expert

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

- A. General
 - 1. Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training and warranty requirements of the project be delegated to a subcontractor.
- B. Demolition
 - 1. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor. All components of the existing BMS that are no longer required as part of the new BMS, shall be removed. This includes abandoned wiring, conduit and pneumatic tubing as a minimum.
- C. Access to Site
 - 1. Unless notified otherwise, entrance to buildings is restricted. No one will be permitted to enter any building unless their names have been cleared with the Owner or the Owner's Representative.
- D. Examination
 - 1. The Contractor shall verify that systems are ready to receive work.
 - 2. The beginning of installation implies that the Contractor accepts the existing conditions.
 - 3. The Contractor shall thoroughly examine the project plans for control device and equipment locations. Discrepancies, conflicts or omissions shall be reported to the Engineer before rough-in work is started.
 - 4. The Contractor shall inspect the site to verify that equipment is installable as designed. Any discrepancies, conflicts or omissions shall be reported to the Engineer before rough-in work is started.
 - 5. The Contractor shall examine the drawings and specifications for work by others. If head room or space conditions appear inadequate or if any discrepancies occur between the plans for work under this contract and the plans for work by others, the discrepancies shall be reported to the Engineer and the contractor shall obtain written instructions from

the Owner for any changes necessary to accommodate the work under this contract with the work of others.

E. Protection:

1. The Contractor shall protect against and be liable for damage to work and to material caused by the Contractor's work or employees.
2. The Contractor shall be responsible for work and equipment until inspected, tested and accepted.
3. The Contractor shall be responsible for protecting materials awaiting installation.
4. The Contractor shall cover open ends systems and system components with temporary covers, plugs or other methods of closure during storage and construction to prevent entry of foreign objects.

F. Continuity of Existing System Operation:

1. When it is necessary to take an existing system offline on a piece of equipment that is servicing occupied areas – before commencing any work – all work must be coordinated with other pertinent contractors and the owner's representative for an agreeable temporary solution. IE: AHU may use a temporary t-stat in the return duct to control a chilled water valve where the unit is placed in "Hand" with the fan running 24hrs.

G. Site Meetings:

1. The Project Manager for the Contractor shall attend a weekly site coordination meeting that will be attended by all of the contractors involved in this project. The Contractor shall allocate a minimum of 3 hours for this meeting. At the first meeting of each month, the status report submittals shall be delivered to the Owner.

H. General Workmanship:

1. The Contractor shall install all wiring in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.
2. Where discrepancies are found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 shall prevail for work specified in Division 17.
3. The Contractor shall install equipment, piping, and wiring/raceways parallel to building lines (i.e. horizontal, vertical and parallel to walls) wherever possible.
4. The Contractor shall provide sufficient slack and flexible connections to allow for vibration of piping and equipment such that the vibration shall not cause electrical connections to break.
5. The Contractor shall verify the integrity of all wiring to ensure continuity and freedom from shorts and grounds.
6. All equipment, installation and wiring shall comply with acceptable industry specifications and standards for performance, reliability and compatibility and be executed in strict adherence to local codes and standard practices.

I. Field Quality Control:

1. The Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

2. The Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

J. Coordination With Other Contractors:

1. The Contractor shall assist in coordinating space conditions to accommodate the work under this contract and work by others.
2. Where options exist, the Contractor shall choose execution methodologies that minimize interference with the execution of work by others.
3. The Contractor shall coordinate work schedules with the other contractors that work in the same area to facilitate mutual progress.

K. Coordination With Test and Balance Contractor:

1. The Contractor shall coordinate work progress with the Test and Balance Contractor such that systems and controls are operational when the Test and Balance Contractor arrives to perform the test and balance tasks. If the Test and Balance Contractor schedules his work without regard to the work progress information provided, and cannot complete the tasks, no liability shall accrue to the Contractor.
2. If the Test and Balance Contractor requires technician support for the test and balance tasks, the availability of the technician shall be coordinated with the Test and Balance Contractor. The Contractor shall not impede the completion of test and balance tasks once systems are ready for test and balance.
3. If the Test and Balance Contractor requires training on the BMS system in order to execute the test and balance tasks, the Contractor shall schedule and deliver this training at an appropriate time relative to the test and balance schedule of work.

L. Coordination With Commissioning Contractor:

1. The Contractor shall coordinate work progress with the Commissioning Contractor such that systems and controls are ready for commissioning when the Commissioning Contractor arrives to perform the test and balance tasks. If the Commissioning Contractor schedules his work without regard to the work progress information provided, and cannot complete tasks, no liability shall accrue to the Contractor.
2. When a system is ready for commissioning, the Contractor shall provide the technician support described in this document in a timely manner.
3. If the Commission Contractor requires training on the BMS system in order to execute the commissioning tasks, the Contractor shall schedule and deliver this training at an appropriate time relative to the commissioning schedule of work.

M. Coordination With the Owner for Operator Training

1. The Contractor shall advise the Owner when the system is sufficiently complete for the operator training to be scheduled.
2. The Owner shall then provide a minimum of two week's notice that the owner's personnel are available for the training.

3.2 INSTALLATION REQUIREMENTS

A. Existing Equipment

1. Interconnecting control wiring that becomes obsolete as a result of new work shall be removed by the Contractor and become the property of the Contractor unless specifically advised otherwise by the owner.
2. Pneumatic tubing that becomes obsolete as a result of new work shall be removed by the Contractor and become the property of the Contractor unless specifically advised otherwise by the owner.
3. Control panels that become obsolete as a result of new work shall be removed by the contractor and delivered to the Owner.
4. Unless otherwise specified on the contract drawings, the Contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers or actuators. Should the Contractor find existing equipment that does not operate properly or is need of maintenance or repair, the Contractor shall notify the Owner.
5. Unless otherwise specified on the contract drawings, the Contractor may reuse existing temperature sensor wells in piping for temperature sensors. The Contractor shall modify the existing wells as necessary for proper fit of the new sensors.
6. Where existing items are no longer required, the Contractor shall remove the items and deliver them to the Owner unless notified otherwise, in which case they will become the property of the Contractor.
 - a. Thermostats
 - b. Controllers
 - c. Auxiliary Electronic Devices
 - d. Pneumatic Controllers
 - e. Damper Actuators, Linkages and Appurtenances
 - f. Control Valves
7. When the Contractor acquires removed equipment items and chooses to dispose of them, the disposal process must meet all the local requirements for general disposal and hazardous materials disposal.

B. Wiring, Conduit, Cable Characteristics and Installation Details

1. All wire shall be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 Volt
Communications	Per the Manufacturer	Per the Manufacturer

2. Power and Class One wiring may be run in the same conduit.

3. Class Two and Class Three wiring and communications wiring may be run in the same conduit.
4. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
5. Unless a written exception provided by the FAA Resident Engineer, all system wiring must be in conduit or an acceptable wireway/cabletray wiring support system ALL conduit must be a minimum of 3/4" and shall be installed in the following manner:
 - a. Parallel and perpendicular to all building lines.
 - b. EMT is acceptable in interior locations not subject to physical damage and above 10' for surface mount applications..
 - c. All conduit shall be BLUE in color to clearly identify control system raceways.
 - d. All conduit/flexible conduit and other raceways must be strapped and fastened as per NEC Electrical Code requirements.
 - e. Rigid or IMC conduit shall be utilized for all exterior locations and interior locations below 10'.
 - f. All exterior installations shall utilize stainless steel hardware and J-boxes. As an alternate, an approved weather shield may be provided as part of an assembly by a single manufacture.
 - g. Control wiring and conduit shall not block or restrict access to any serviceable areas (doors, openings, etc.)
 - h. When permissible, wiring above accessible ceilings may be run in cable tray with conduit fasteners or in J-Hooks fastened to structure.
6. Flexible metallic conduit with a maximum length of 3 feet shall be used for connections to motors, actuators, controllers and sensors mounted on vibrations producing equipment. Liquid-tight flexible conduit shall be used in exterior locations and interior locations subject to moisture.
7. Junction boxes shall be provided at all cable splices, equipment termination and transitions from EMT to flexible conduit. Interior J-boxes shall be galvanized pressed steel, nominal four inch square with black cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and covers with gaskets.
8. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated.—~~Teflon~~ Plenum wiring can be run without conduit above suspended ceilings.
 - a. Exception: Any wire run in suspended ceilings that must be intact for the fire management system to control building systems, shall be installed in conduit.
9. Low voltage wiring shall meet National Electric Code Class 2 requirements. Sub-fuse low voltage power circuits as required to meet Class 2 current limits.
10. All wiring in mechanical, electrical, or service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.
11. Where Class 2 wiring is exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.
12. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

13. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire to wire connections shall be at a terminal block.
14. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
15. Maximum allowable voltage for control wiring shall be 77 Volts. If only higher voltages are available, the contractor shall provide step-down transformers.
16. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
17. Install plenum wiring in sleeves where it passes through walls and floors. Maintain the fire rating at all penetrations.
18. The size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and National Electric Code requirements, except as noted elsewhere.
19. Include one pull string in each raceway that is 1 inch in diameter or larger.
20. Use coded conductors throughout with conductors of different colors.
21. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
22. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway, to maintain a minimum clearance of 6 inches from high-temperature equipment such as steam pipes or flues.
23. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
24. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
25. The contractor shall terminate all control and/or interlock wiring and shall maintain updated as-built wiring diagrams with terminations identified at the job site.
26. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with coupling according to code. Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.
27. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
28. Only glass fiber is acceptable, no plastic.
29. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BMS contractor shall submit to the Owner the name of the intended contractor of the fiber optic cable with the project submittals.

C. Communication Wiring:

1. The contractor shall adhere to the items listed in the previous section on WIRING.
2. The contractor shall install all cabling in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
3. The contractor shall not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
4. Communication cables shall be protected by a surge arrestor device in the following instances (known acceptable source: SA-1 manufactured by Schneider Electric):
 - a. Vertical conduit/wiring.
 - b. Underground conduit/wiring.

- c. Above ground conduit/wiring exiting and/or entering the building envelope.
- 5. The contractor shall install all runs of communication wiring with un-spliced lengths when that length is commercially available.
- 6. The contractor shall label all communication wiring to indicate origination and destination data.
- 7. When shielded wiring is use, the contractor shall ground the shield only once for each continuous segment of cable.
 - a. The shield shall be grounded at the NSC for the RS485 cable that connects to the NSC.
 - b. The shield shall be grounded at the RS485 router when a router is used to add a downstream RS485 LAN.
- 8. All wiring shall be terminated in an approved junction box, conduit or other approved enclosure.
- 9. All wiring shall be run continuously from origin to its final termination point.

D. General Installation Practices for Field Devices

- 1. Well mounted sensors shall include thermal conducting compound within the well to ensure good heat transfer to the sensor.
- 2. Actuators shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- 3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
- 4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

E. Sensors:

- 1. The contractor shall install sensors in accordance with the manufacturer's recommendations.
- 2. The location of sensors shall be as indicated on mechanical and architectural drawings.
- 3. The contractor shall mount sensors rigidly and adequately for the environment within which the sensor operates.
- 4. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- 5. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- 6. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- 7. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.
- 8. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in the thermal wells.
- 9. Install outdoor air temperature sensors on the north wall, complete with a sun shield at the designated location.

F. Differential air pressure and static pressure sensors:

1. The location of pressure sensors shall be as indicated on the mechanical and architectural drawings.
2. For supply duct static pressure, pipe the high pressure tap to a duct probe that measures at a 90 degree angle to flow (to measure only the static pressure and not the effects of velocity). Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor if one is installed or to the plenum if a building static pressure sensor is not installed.
3. For return duct static pressure, pipe the high pressure tap to a duct probe that measures at a 90 degree angle to flow (to measure only the static pressure and not the effects of velocity). Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor if one is installed or to the plenum if a building static pressure sensor is not installed.
4. For building static pressure, pipe the low-pressure port of the sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
5. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
6. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels and not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without the use of ladders or special equipment to the maximum extent possible.
7. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.
8. Annular pitot tubes shall be installed so that the total head pressure ports are set-in-line with the pipe axis upstream and the static port facing downstream. The total head pressure ports shall extend diametrically across the entire pipe. Annular pitot tubes shall not be used where the flow is pulsating or where pipe vibration exists.

G. Flow Switches:

1. The location of flow switches shall be as indicated on the mechanical and architectural drawings.
2. Airflow Switches
 - a. Install in horizontal duct runs whenever possible.
 - b. If a vertical duct run is the only option, then install in a location with an upward airflow.
3. Hydronic Switches
 - a. Use the correct paddle type for the pipe diameter as described by the switch manufacturer.
 - b. Adjust the flow switch in accordance with the manufacturer's instructions.

H. Actuators:

1. Damper actuators shall be provided with all mounting hardware and linkages.
2. Mount and link control damper actuators according to manufacturer's instructions.

3. When spring return actuators are used on normally closed dampers, the seals shall be compressed when the dampers have been closed by the actuator.
4. Damper/actuator combinations shall modulate smoothly from fully closed to fully open and return.
5. Electric/Electronic Damper Actuators shall be direct-mounted on the damper shaft or jackshaft unless shown as a linkage installation. They shall be mounted following the actuator manufacturer's recommendations.
6. Electric/Electronic Valve Actuators shall be connected to the valve with adapters approved by the actuator manufacturer. They shall be mounted following the actuator manufacturer's recommendations.

I. Controllers:

1. Install programmable process controllers, supervisory logic controllers and application specific devices on each field bus to meet the requirements of the sequence of control for all systems.
 - a. SLCs shall only be used when the NSC is unable to support supervisory logic in support of field bus controllers.
2. All process control loops for an integral system shall reside in a single controller. Each controllable end device creates one process control loop. Examples of integral systems are:
 - a. Air handling units
 - b. Packaged chillers
 - c. Chillers, excluding pumps and tower
 - d. Boilers
3. To the maximum extent possible, all process control loops for built up systems shall reside in a single controller. An example is a chiller with its associated chilled water and condenser water pumping systems or a boiler system with steam to hot water heat exchangers. The objective of this requirement is that the contractor shall use large point count, primary controllers in lieu of multiple secondary controllers.
4. To the maximum extent possible supervisory logic for integral and built up systems shall reside in the NSC.

J. Control Dampers:

1. Install dampers in accordance with the manufacturer's instructions to operate and to obtain leakage rates specified herein. Adjust the damper linkage such that the damper closes before the actuator is fully closed to assure tight shutoff of the damper.
2. Blank-off and seal around dampers and between dampers and sleeves or frames to eliminate air bypass.
3. For outdoor air damper assemblies, stage the opening of each section to prevent stratification and poor mixing of outside and return air.

K. Control Valves:

1. Install in an accessible location, with room for actuator removal and service. Adjust the actuator to provide tight shutoff. Provide valve stem indicator and adjust to indicate proper travel.
2. Where butterfly valves are used, permanently mark the end of the valve shaft to indicate the valve position.

L. Warning Labels:

1. The contractor shall affix permanent warning labels to all equipment that can be automatically started by the DDC system.
 - a. Labels shall use white lettering, 12 point type or larger, on a red background.
 - b. The labels shall read: "CAUTION: This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to the OFF position before servicing."
2. The contractor shall affix permanent warning labels to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
 - a. Labels shall use white lettering, 12 point type or larger, on a red background.
3. The labels shall read: "CAUTION: This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing."

M. Identification of Hardware and Wiring

1. The contractor shall label all wiring and cable, including that within factory-fabricated panels, at each end and within 2 inches of the end of the cable with the DDC address or termination number.
2. The contractor shall label all pneumatic tubing at each end within 2 inches of the end with a descriptive identifier.
3. The contractor shall label or code each point of field terminal strips to show the instrument or item served.
4. The contractor shall label all control panels with minimum ½ inch letters on laminated plastic nameplates.
5. The contractor shall identify all other control components with permanent labels. All plug-in components shall be labeled on both the removable component and the permanently installed base such that it is obvious where the removed component is to be re-installed.
6. The contractor shall label room sensors relating to terminal box or valves with nameplates.
7. Manufacturer's nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
8. All identifiers shall match the as-built documents.

N. ~~xiv~~ Network Server Controllers

1. Connect NSCs to the owner's TCP/IP network. Locations are identified on the drawings.

2. The NSCs shall be configured and commissioned to ensure that the only data traffic on the TCP/IP is data that is essential for operation of the system. Messages between field devices on the same field bus shall not be allowed to pass onto the TCP/IP network.
3. The NSCs shall be configured to also serve as Web Servers to Web Based Operator Stations.
4. The NSCs shall be linked to the ES database.

O. Enterprise Server

1. The Contractor shall install the Enterprise Server in the location defined on the contract drawings or in a location specified by the Owner.
2. The ES shall be configured to also serve as a Web Server to Web Based Operator Stations.

P. Engineering/Operator Workstation

1. The Contractor shall install the Engineering/Operator Workstation in the location defined on the contract drawings or in a location specified by the Owner.
2. The IP address shall be as assigned by the Owner's IT Department.

Q. The Contractor shall install, license, initialize, start-up and debug all software required for a complete and operational system. This includes any operating system software or other third party software necessary for the successful operation of the system.

R. The Contractor shall provide a complete database and all controller applications to meet the sequence of control and operator interaction requirements.

3.3 DISTRIBUTED CONTROL REQUIREMENTS

- A. The programmed applications for a single integrated system shall not be distributed over more than one field bus.
- B. Example 1: A chiller is controlled by a controller on field bus number 1. The controllers that control the pumps and tower shall also be on field bus number 1 as these systems are integrated in their control requirements.
- C. Example 2: Multiple air handling units are controlled by controllers on field bus number 1 under NSC number 1. The chiller system is controlled by NSC number 2. The chiller control logic requires the chilled water valve positions from each of the air handling unit controllers. It is acceptable that these related but non-integral systems are controlled by controllers on different field busses or by a second NSC.

3.4 PROGRAMMING FOR NSCS, PROGRAMMABLE PROCESS CONTROLLERS AND SUPERVISORY LOGIC CONTROLLERS

- A. The contractor shall create and download application programs that meet the requirements of the sequence of control, time scheduling requirements, trend logging requirements and alarm handling requirements.

- B. The contractor shall use a consistent point naming concept throughout the project that allows for easy transition from building to building and system to system.
- C. All time schedules shall be fully configured with weekly schedules and all of the holidays identified by the owner.
- D. All trend logs identified in the sequence of control shall be fully configured and operational.
- E. All alarm handling shall be fully configured with consistent alarm messages and priorities or category numbers to identify the system from which the alarm originates.
- F. All user adjustable parameters identified as (adj) in the sequence of control shall be viewable and writable and appropriate initial values shall be set.
- G. All external point values and internal point values identified as (rpt) in the sequence of control shall be viewable.
- H. Manual control (force by operator) of all external points shall be possible from list views and graphics. The forced by operator status of a point shall be readily visible to the system operator from both the list views and graphics.
- I. For all variables broadcast onto the field bus, event driven communication shall be used to avoid data storms. As a minimum the program shall provide for the use of at least two of the following three parameters for each output network variable:
 - 1. Send on delta parameter
 - 2. Minimum send time parameter for each output variable.
 - 3. Maximum send time (guaranteed transfer time)
- J. The contractor shall embed into the programs sufficient comment statements to clearly describe each section of the program. This applies to both line programming and graphical programming system.
- K. With graphical programming systems with multiple layers for the function block diagrams are used, no more than two layers shall be used.

3.5 CONFIGURATION OF APPLICATION SPECIFIC CONTROLLERS

- A. Application Specific Controllers shall be fully configured to meet the sequence of control and physical characteristics of the equipment being controlled.
 - 1. Physical device selection parameters (series fan or parallel fan, etc.)
 - 2. Thermodynamic parameters (cooling set point, heating set point, etc.)
 - 3. Timing parameters (sample rates, integral time constants, etc.)
 - 4. Communication parameters (send heartbeat, minimum send time, etc.)
- B. For each ASD, documentation of all parameter settings shall be included in the as-built submittals.

3.6 DEVICE TO DEVICE DATA FLOW ON THE FT-10A FIELD BUS

- A. This includes control data flow between the NSC and Lon field bus controllers.
- B. All device-to-device data flow shall be in place and configured to meet the sequence of control for the new systems and to integrate the existing systems.
- C. All device-to-device data flow shall be implemented through the use of LonTalk variables with an appropriate SNVT.
- D. Appropriate binding services shall be used to ensure that the average bandwidth utilization is less than 30%. The owner reserves the right to conduct network bandwidth testing to ensure this requirement is met.
- E. If reducing the number of devices per field bus is required to meet the network bandwidth requirements, all costs of making changes shall be borne by the contractor.

3.7 SYSTEM UNITS FOR LON BASED PPCS, SLCS AND ASDS

- A. The contractor shall use SNVTs with the appropriate units for each input network variable, input application parameter and output network variable.
- B. The contractor shall use SCPTs with the appropriate structure for each input application parameter that is based on the SCPT concept.
- C. The data shall be presented to the operators visually and using the inch-pound system. The conversion of data from a field level device must be automatically converted from SI units to inch-pound units prior to display.
- D. For operator initiated values, the operator shall be able to enter values in units from the inch-pound system of units and the system must then automatically convert the value to units from the SI system of units for dispatch to the field level devices.

3.8 GRAPHIC PAGES

- A. Graphic Page Requirements
 - 1. The sequence of control defines the buildings and all of the equipment items to be controlled by the BMS. Graphic pages shall be constructed as described below as applicable (If a central plant is not part of this project, the requirements described below for central plant graphics are moot).
 - 2. The contractor shall develop additional graphic pages to be defined by the owner during the construction period as follows:
 - a. Up to five additional pages per building.
 - b. Up to twenty additional global pages when a project involves more than one building.
- B. Hierarchy

1. The organization of graphic pages shall be from a global level down to a very detailed level through a series of links.
2. Linking shall allow the operator to move down the hierarchy, up the hierarchy and laterally within the hierarchy.

C. Hierarchy Outline

1. Site Plan Page: A visual representation of the site (map). One page or multiple linked pages depending on the size of the site plan.
 - a. Link to individual building graphic pages.
 - b. Display outdoor weather conditions.
2. Utility Management Page: A summary of data on the utility consumption for the site.
 - a. Link up to the site plan.
 - b. Display
 - 1) Utility consumption data.
 - a) Demand data.
 - b) Voltages, currents and power factors.
 - c) Demand control actions currently in effect.
 - c. Presenting the utility management data may require more than one graphic page to effectively report the data from multiple meters.
3. Building Graphic Page: Typically a picture of the building. One page per building.
 - a. Link to floor plans within the building.
 - b. Link to central plant graphics where the plant serves the entire building.
 - c. Link to delivery systems if the delivery system serves the entire building
 - d. Link up to the site plan.
4. Floor Plan Page: This will be a two dimensional plan of a floor area. A minimum of one page per floor per building is required. Where floor plans are large, multiple linked pages are required. For each control zone the value of the controlled parameters shall be displayed. This will typically be lighting status, temperature and relative humidity if relative humidity is a controlled variable.
 - a. Link up to the Building page.
 - b. Link up to the Site Plan page.
 - c. Link to any delivery system that serves the floor plan area (air handling unit is typical).
 - d. Link to time schedules that affect the systems that serve the area
 - e. Link to a Terminal Unit Summary page where multiple zones on the floor are served by unitary control devices such a VAVs or fan coil units.
 - f. Individual control zones shall be identified.
 - g. The location of terminal equipment serving each zone shall be shown.
 - h. The location of sensors installed in the occupied space shall be shown.

- i. Where room numbers are available, they shall be shown.
 - j. Floor plan to be requested in CAD from the general contractor.
5. Central Plant Page: A graphical representation of the equipment that makes up the plant such as chillers, pumps, boilers, towers etc. If the plant is small, this graphic will display the values of process variables and commands to end devices. If the plant is complex this graphic will just contain links to equipment graphics. A page for each plant is required.
- a. Link up to the Building page.
 - b. Link up to the Site Plan page.
 - c. Link to Central Plant Equipment Component page (chiller, pumps, tower, etc.).
 - d. The graphic representation of the equipment shall be 3-dimensional.
 - e. Display:
 - 1) Process variables.
 - 2) Commands to end devices.
 - 3) Status of end devices.
 - 4) Alarm points if this is the only central plant graphic.
 - 5) Plant status (enabled/disabled).
 - 6) Demand control status.
 - f. Link to any time schedules that affect the operation of the plant.
 - g. Link to any pre-configured trend charts associated with the performance of the plant.
 - h. Link to a Central Plant Configuration Page.
6. Central Plant Equipment Component Page: A graphical representation of an element of equipment such as a chiller, pumps, boiler or tower or some combination of all of these. A page for each primary equipment item per plant is required.
- a. Link up to the Central Plant page.
 - b. Link up to the Building page.
 - c. Link up to the Site Plan page.
 - d. The graphic representation of the equipment shall be 3-dimensional.
 - e. Display:
 - 1) Process variables.
 - 2) Commands to end devices.
 - 3) Status of end devices.
 - 4) Alarm points.
 - 5) Equipment status (enabled/disabled).
 - 6) Demand control status.
 - f. Link to any time schedules that affect the operation of the equipment component.
 - g. Link to any pre-configured trend charts associated with the performance of the equipment component.
 - h. Link to a Central Plant Configuration Page.

7. Central Plant Configuration Page: On this page the operator is given access to the configuration parameters for the entire plant or a piece of equipment in the plant. Typically, this page presents data in a tabular format. The type of data on this page is not changed frequently, but the operator may wish to view it frequently. One page per plant for small plants and one page per primary equipment item per plant for larger plants are required.
 - a. Set Points.
 - b. Tuning Parameters.
 - c. Calibration Parameters.
 - d. Timing Parameters.
 - e. Application parameters.
 - f. Reset Schedules.
 - g. Lead Lag Information.
 - h. Time Schedules.
 - i. Link up to the Equipment or Central Plant page.
 - j. Link up to the Building page.
8. Delivery System Page: A graphical representation of an air or water delivery system such as an air handling unit, roof top air handling unit, computer room air conditioning unit. One page for each delivery system.
 - a. If the Delivery System serves a specific floor area, link up to the Floor Area page.
 - b. Link up to the Building page.
 - c. Link up to the Site Plan page.
 - d. Link to the Central Plant page if the Delivery System is served by a Central Plant.
 - e. If the Delivery System supplies multiple terminal devices, link to a Terminal Unit Summary page.
 - f. Link to a Delivery System Configuration page.
 - g. The graphical representation of the equipment shall be 3-dimensional and represent the true physical characteristics of the installed system.
 - h. Display:
 - 1) Process variables.
 - 2) Commands to end devices.
 - 3) Status of end devices.
 - 4) Status of different modes (economizer on/off, mechanical cooling enabled/disabled, occupied/unoccupied).
 - 5) Alarm points.
 - i. Link to any time schedules that affect the system operation.
 - j. Link to any pre-configured trend charts for the system.
9. Delivery System Configuration Page: On this page the operator is given access to the configuration parameters for the delivery system. Typically, this page presents data in a tabular format. The type of data on this page is not changed frequently, but the operator may wish to view it frequently. One page per delivery system is required.
 - a. Display:

- 1) Set Points.
 - 2) Tuning Parameters.
 - 3) Calibration Parameters.
 - 4) Timing Parameters.
 - 5) Application parameters.
 - 6) Reset Schedules.
 - 7) Lead Lag Information
 - 8) Time Schedules.
 - b. Link up to the Delivery System page.
 - c. Link up to the Building page.
 - d. Link up to the Site Plan page.
10. Terminal Equipment Summary Page: On this page the dynamic data and set points that are associated with multiple terminal units are presented in a tabular format. The objective is to present a summary of terminal unit performance for an area of the facility. One page is required for each group of terminal units. In the tabular data, do not use less than 12 pt font size. Multiple linked pages may be used if there are a large number of terminals served by one delivery system.
 - a. Display in the table:
 - 1) Process variables.
 - 2) Set points for each process.
 - 3) Command to each end device.
 - 4) Status of each end device.
 - 5) Load factors such as terminal load for a VAV terminal unit.
 - b. Link to the page for each Terminal Unit.
 - c. Link up to the Delivery System page.
 - d. Link up to the Floor Plan page.
 - e. Link up to the Building page.
 - f. Link up to the Site Plan page.
11. Terminal Unit Page: A graphical representation of a terminal unit such as a VAV terminal or fan coil terminal. One page for each terminal unit.
 - a. Link up to the Terminal Summary page.
 - b. Link up to the Floor Plan page.
 - c. Link up to the Building page.
 - d. Link up to the Site Plan page.
 - e. The graphic representation of the equipment shall be 3-dimensional and shall represent the actual installed terminal unit (if the VAV does not have a fan, a fan should not be shown, etc.).
 - f. Display
 - 1) Process variables.
 - 2) Command to end devices.
 - 3) Status of end devices.
 - 4) Set points for each process.

- 5) Modes (auto, heat, cool, etc.).
- 6) Capacity indicators (terminal load, %heat, %cool, etc.).
- 7) Reset schedules.
- 8) Occupancy commands and status.
- 9) Alarm points.

- D. For all points on a graphic page that are subject to being under manual or test mode, the display shall indicate when test mode or manual mode has been applied to the point.

3.9 DEFAULT GRAPHIC PAGES

- A. It shall be possible to assign a specific graphic page as a “Default System Graphic” for each User Group and/or each User setup within the system.
- B. When a User signs onto the system, the “Default System Page” shall be displayed. Using links, the User may then move from page to page within the system.

3.10 AUTOMATIC TIME OUT

- A. When a workstation detects no activity for a specific period of time, the system shall automatically logout the connected user.
- B. The same User or a different User shall then be required to enter their User Name and Password to re-enter the system.

3.11 TREND DATA PRESENTATION

- A. Trend data shall be presentable in a trend log list with the time stamp and value presented in two columns of data.
 1. It shall be possible to copy the data from a trend log list to Microsoft Excel.
- B. Trend data shall be presented in trend charts where one or more variables are displayed graphically with the value on the “Y” axis and time on the “X” axis.
 1. Each trend chart shall support up to two sets of engineering units for the “Y” axis, one on the left axis and one on the right axis.
 2. A single chart may be used to display multiple trend logs as long as the trend logs use one of the two possible engineering unit scales.
 3. All trend logs shall be included in a trend chart. The operator shall not be required to create a chart to view the data.
 4. The creation process for trend charts shall be native to the system and not require a third party software package.
 5. At the operator’s discretion, polling based trend data shall be presented in a trend chart format.

3.12 DYNAMIC APPLICATION FLOW CHARTS

- A. Graphically programmed applications in the NSC shall have a graphical viewer that allows the application to be presented in real time with current values displayed on the graphical program with periodic updates. This graphical viewer shall present itself via workstation.
- B. Graphically programmed applications in programmable process controllers and supervisory logic controllers shall allow the application to be presented in real time with current values displayed on the graphical program with periodic updates. This viewer shall present itself to a directly connected service laptop running the application programming tool.

3.13 USER GROUPS

- A. The contractor shall configure four users groups, one for each level of security. The group names shall be representative of the “names” below:
 - 1. Administrators
 - 2. Engineers
 - 3. Operators
 - 4. Viewers
- B. Users
 - 1. The contractor shall configure two users in each user group. The names and passwords shall be representative of the “names” below:
 - a. Administrators Group
 - 1) Admin1 / Admin1
 - 2) Admin2 / Admin2
 - b. Engineers Group
 - 1) Engr1 / Engr1
 - 2) Engr2 / Engr2
 - c. Operators Group
 - 1) Oper1 / Oper1
 - 2) Oper2 / Oper2
 - d. Viewers Group
 - 1) View1 / View1
 - 2) View2 / View2
 - 2. Administrators shall have full authority over the entire system.
 - 3. Engineers shall have the ability to create, edit, control and view but they shall not be able to add users or set passwords.
 - 4. Operators shall have the ability to control and view only.
 - 5. Viewers shall have the ability to view only.

- C. With the exception of the Viewers Group, these users shall not be added to the system until all testing has been completed and the system has been accepted. The contractor shall accept all responsibility for actions that result from the unauthorized issuance of user names and passwords above the level of viewers prior to system acceptance unless specifically instructed to do so in writing by the owner.

3.14 ALARM PROCESSING

- A. All alarms required by the sequence of control shall be fully configured for delivery to the operator workstations and the alarm files.
- B. A common alarm viewer shall be established to receive alarms from all of the field devices.
- C. A separate alarm viewer shall be established on a per building basis to receive just the alarms from that building.
- D. It shall be possible to setup unique alarm viewers based on the alarm category (a number from 1 to 1000 assigned to each alarm).
- E. The alarm messages shall be descriptive and include as a minimum:
 - 1. System identification
 - 2. Date
 - 3. Time
 - 4. Nature of the alarm such as high value, low value, or fail to start.
- F. The system shall be configured to send an alarm message on return to normal.
- G. Upon system turnover, all users shall receive all alarms but the system shall have the ability to expose alarm messages to specific users or user groups as desired by the system manager.

3.15 START-UP TESTING

- A. The contractor shall furnish all labor and test apparatus required to execute the start up testing plan. Key tasks to be executed and documented in the start-up testing report include:
- B. Verification of all primary and secondary voltages.
- C. Verification that power wiring for all devices conforms to manufacturer's instructions.
- D. Verification that all labeling is in place.
- E. Inspection of wiring for loose strands and tight connections.
- F. Verification of field bus topology, grounding of shields (if used) and installation of termination devices.
- G. Verification that all devices are installed per the architectural submittal.

- H. Verification that each I/O device is landed per the submittals and functions per the sequence of control.
 - 1. Analog sensors shall be properly scaled and a value reported to the OWS.
 - 2. Binary sensors shall have the specified normal position and the correct state is reported to the OWS.
 - 3. Analog outputs have the specified normal position and move full stroke when so commanded.
 - 4. Binary outputs have the specified normal state and respond to energize/de-energize commands.
- I. The start-up testing report shall identify the date each task was completed and include the initials of the technician performing the task.
- J. The Contractor shall keep the Owner informed of the start-up testing schedule. At least one week's notice must be provided so that the Owner or Owner's representation may observe the execution of the start-up tasks.
- K. The Owner shall keep the Contractor informed of any plan to observe the start-up tasks via the weekly management meeting or by email.

3.16 CALIBRATION

- A. The Contractor shall ensure that all analog sensors have been calibrated with high quality instrumentation suitable for the sensor being calibrated.
 - 1. The instruments shall display a current (12 month) NIST traceable calibration sticker. Associated instrument calibration certificates shall be made available within 24 hours of a request.
 - 2. The measured value, reported value, and the calculated offset that was entered into the database shall be recorded.
 - 3. The calibration criteria shall be:
 - a. Space Temperature: +/- 0.4 degrees F
 - b. Air Temperature: +/- 0.5 degrees F
 - c. Fluid Temperature: +/- 0.5 degrees F
 - d. Air Flow Rate: +/- 5 %
 - e. Liquid Flow Rate: +/- 5 %
 - f. Differential Pressure: +/- 3 %
 - g. Gauge Pressure: +/- 5%
 - h. Relative Humidity: +/- 3 % relative humidity
 - i. CO2: +/- 2 %
- B. The Contractor shall document all calibration tasks:
 - 1. Name and location of the sensor
 - 2. Measured value
 - 3. Reported value
 - 4. Date of calibration

5. Initials of the technician performing the task
 6. The Calibration Report shall include all of the above.
- C. The Contractor shall keep the Owner informed of the calibration schedule. At least one week's notice must be provided so that the Owner or Owner's representation may observe the execution of the calibration tasks.
- D. The Owner shall keep the Contractor informed of any plan to observe the calibration tasks via the weekly management meeting or by email.

3.17 LOOP TUNING

- A. The contractor shall tune all P, PI and PID control loops under typical operating conditions. Example: A chilled water control loop typically operates between 50 and 65 degrees F. The loop shall be tuned when the chilled water is within this typical operating range. This may require off-season tuning.
- B. The PID control applications shall provide for stable changes to loop set points (how often and by how much), so that derivative control is not required unless absolutely necessary.
- C. The loop tuning criteria shall be a stable control loop where the average error over 15 minutes and 30 samples shall be less than:
1. Space Temperature: +/- 0.75 degrees F
 2. Air Temperature: +/- 1.50 degrees F
 3. Air Humidity: +/- 5 % relative humidity
 4. Chilled Water Temp: +/- 1.00 degrees F
 5. Hot Water Temp: +/- 1.00 degrees F
 6. Duct Pressure: +/- 0.2 inches w.g
- D. The Contractor shall document all loop tuning tasks.
1. Name and location of the control loop
 2. Results of the tuning
 - a. Gain in percent per unit of measure
 - b. Integral time constant in seconds or Integral Gain in percent per unit of measure per second
- E. The Contractor shall keep the Owner informed of the tuning schedule. At least one week's notice must be provided so that the Owner or Owner's representation may observe the execution of the tuning tasks.
- F. The Owner shall keep the Contractor informed of any plan to observe the calibration tasks via the weekly management meeting or by email.
- G. The Owner shall keep the Contractor informed of any plan to observe the tuning tasks via the weekly management meeting or by email.

3.18 PERFORMANCE VERIFICATION TESTING

- A. The Contractor shall verify that the performance of the system conforms to the sequence of control.
 - 1. The Contractor shall execute a series of cause and effect tests to ensure that each aspect of the sequence of control is fully implemented.
- B. The Contractor shall document:
 - 1. A definition of each functional test
 - 2. The date the test was conducted
 - 3. The initials of the technician performing the test
- C. The Contractor shall keep the Owner informed of the tuning schedule. At least one week's notice must be provided so that the Owner or Owner's representation may observe the execution of the functional testing.
- D. The Owner shall keep the Contractor informed of any plan to observe the performance verification via the weekly management meeting or by email.
- E. This work shall be coordinated with the commissioning agent if applicable.

3.19 OPERATOR INTERACTION TESTING

- A. The Contractor shall verify that the performance of the system conforms to the drawings and specification for both an operator workstation and a web based operator interface.
 - 1. Graphics navigation
 - 2. Trend data collection and presentation
 - 3. Alarm handling, acknowledgement and routing
 - 4. Time schedule editing
 - 5. User adjustable parameter adjustments
 - 6. Manual control of points and values
 - 7. System backup process
- B. The Contractor shall document:
 - 1. A brief description of each task
 - 2. The date the test was conducted
 - 3. The initials of the technician performing the test
- C. The Contractor shall keep the Owner informed of the operator interaction testing schedule. At least one week's notice must be provided so that the Owner or Owner's representation may observe the execution of the testing.
- D. The Owner shall keep the Contractor informed of any plan to observe the operator interaction testing via the weekly management meeting or by email.

3.20 PERSONNEL AND EQUIPMENT FOR TESTING

- A. The Contractor shall provide all labor and equipment required to perform:
 - 1. Start-Up Testing
 - 2. Functional Testing
 - 3. Calibration
 - 4. Tuning
 - 5. Operator Interaction Testing
- B. The Contractor personnel conducting the testing shall be competent with and knowledgeable of all project specific systems, hardware and software.

3.21 FAILURES AND RE-TESTING

- A. The Contractor shall ensure that all tests achieve satisfactory results.
- B. Failures of any test shall result in corrective action and re-testing by the Contractor.

3.22 ON-SITE TRAINING

- A. The Contractor shall provide six weeks' notice of the scheduled time for the delivery of the on-site training defined in Part 1 of this specification.
- B. The training shall be conducted by an individual that is familiar with the installed system.
- C. The extent of the training and the methodology of delivery shall conform to the information submitted in advance.
- D. The training program is a formal event with hands on activities by the students. It is not a "Watch Me" event. Competency is the objective.

END OF SECTION 23 09 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.3 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: 1/4-inch equals 1 foot.
 - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Welding certificates.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.
- G. Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
 - 2. End Connections:
 - a. NPS 2 and Smaller: With threaded-end connections.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.

4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

B. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psi.
6. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
7. Piston, Closing Spring, and Seat Insert: Stainless steel.
8. Seat Disc: Polytetrafluoroethylene.
9. End Connections: Threaded.
10. Working Pressure Rating: 400 psig.
11. Maximum Operating Temperature: 240 deg F.

C. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500psig.
5. Maximum Operating Temperature: 275 deg F.

D. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.

6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F.
- E. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- F. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 3-1/2 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- D. Safety-Relief-Valve Discharge Piping Schedule 40, black-steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- B. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 1. Install valve so diaphragm case is warmer than bulb.
 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- C. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- D. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 1. Solenoid valves.

2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

E. Install filter dryers per equipment manufacturer recommendations.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- ~~K.~~ Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- L. Slope refrigerant piping as follows:
 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 2. Install horizontal suction lines with a uniform slope downward to compressor.
 3. Install traps and double risers to entrain oil in vertical runs.
 4. Liquid lines may be installed level.
- M. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

- N. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- P. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- Q. Identify refrigerant piping and valves according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Spring hangers to support vertical runs.
 - 4. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.

5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
- E.
 1. Verify that compressor oil level is correct.
 2. Open compressor suction and discharge valves.
 3. Open refrigerant valves except bypass valves that are used for other purposes.

- F. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

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SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.3 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
 4. Materials, fabrication, assembly, and spacing of hangers and supports.
 5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified Licensed Professional Engineer responsible for their preparation for selecting hangers and supports and seismic restraints.
- D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- E. Welding certificates.
- F. Field quality-control reports.
- 1.4 QUALITY ASSURANCE
- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Double-wall Rectangular Duct shall be manufactured with solid metal inner wall and solid metal outer wall, and insulation blanket or foam-injected insulation in between. Insulation shall be no less than R-4. Duct shall be manufactured, assembled and installed to meet SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ECO Duct Products, Inc.
 - b. Lindab Inc.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.

- e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Joint Types shall be flanged and gasketed, slip-connection, or manufacturer-specific connection type. Joints shall be assembled in accordance with manufacturer instructions as required to achieve Seal Class A, and compliant with SMACNA "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Longitudinal seams shall be factory assembled and sealed in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." In order to avoid compromising longitudinal seams, pre-assembled double-wall duct shall not be bent or physically distorted.
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Pre-manufactured fittings, assembled and installed in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Factory- or Shop-Applied Antimicrobial Coating:
 - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
 - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
 - 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

5. Shop-Applied Coating Color: Black.
 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - e. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Natural-Fiber Duct Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor and complying with NFPA 90A or NFPA 90B.
1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Bonded Logic, Inc.
 - b. Reflectix Inc.
 2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested according to ASTM C 518.
 3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to ASTM E 84; certified by an NRTL.
 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel ; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with build outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build outs (metal hat sections) or other build out means are optional; when used, secure build outs to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches .
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

- D. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electro galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by COR from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by COR, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 DUCT CLEANING

- A. Clean duct system(s) before testing, adjusting, and balancing.

- B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
 - a. The contractor shall be responsible to repair all damaged ceiling systems at no cost to the government.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and downstream of Terminal Units :
 - a. Pressure Class: Positive 2-inch wg
 - b. Minimum SMACNA Seal Class: B.
 2. Ducts Connected to Constant-Volume Air-Handling Units :
 - a. Pressure Class: Positive 2-inch wg
 - b. Minimum SMACNA Seal Class: B.
 3. Ducts Connected to Variable-Air-Volume Air-Handling Units :
 - a. Pressure Class: Positive 4-inch wg
 - b. Minimum SMACNA Seal Class: B.
 4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg
 - b. Minimum SMACNA Seal Class: B.
- C. Return Ducts:
 1. Ducts Connected to Fan Coil Units Furnaces, Heat Pumps, and Terminal Units
 - a. Pressure Class: Positive or negative 2-inch wg
 - b. Minimum SMACNA Seal Class: C.
 2. Ducts Connected to Air-Handling Units :
 - a. Pressure Class: Positive or negative 3-inch wg .
 - b. Minimum SMACNA Seal Class: B.
- D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air-Handling Units :
 - a. Pressure Class: Positive or negative 2-inch wg
 - b. Minimum SMACNA Seal Class: B.
- E. Intermediate Reinforcement:
 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
- F. Liner:
 1. Supply Air Ducts: Fibrous glass, Type I, or Flexible elastomeric 1-1/2 inches thick.
 2. Return Air Ducts: Natural fiber, 1 inch thick.
 3. Supply Fan Plenums: Natural fiber, 1-1/2 inches thick.
 4. Transfer Ducts: Natural fiber, 1 inch thick.
- G. Elbow Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type COR 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type COR 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type COR 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- H. Branch Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: 45-degree entry.
 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

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SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Control dampers.
 - 3. Fire dampers.
 - 4. Flange connectors.
 - 5. Turning vanes.
 - 6. Duct-mounted access doors.
 - 7. Flexible connectors.
 - 8. Flexible ducts.
 - 9. Duct accessory hardware.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, installations, including sleeves; and duct-mounted access doors
 - e. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

- B. Comply with AMCA 500-D testing for damper rating.

1.4 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized- steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel
7. Bearings:
 - a. Molded synthetic
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.
2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Galvanized-steel channels, 0.064 inch thick.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized roll-formed steel, 0.064 inch thick.
6. Blade Axles: ~~Nonferrous metal~~ Galvanized steel.
7. Bearings:
 - a. Molded synthetic
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene
9. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

2.3 CONTROL DAMPERS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Arrow United Industries; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Duro Dyne Inc.
 5. Flexmaster U.S.A., Inc.
 6. Greenheck Fan Corporation.
 7. Lloyd Industries, Inc.
 8. M&I Air Systems Engineering; Division of M&I Heat Transfer Products Ltd.
 9. McGill AirFlow LLC.
 10. METALAIRE, Inc.
 11. Metal Form Manufacturing, Inc.
 12. Nailor Industries Inc.
 13. NCA Manufacturing, Inc.
 14. Ruskin Company.
 15. Vent Products Company, Inc.
 16. Young Regulator Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 1. Hat shaped.
 2. Galvanized-steel channels, 0.064 inch thick.

3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 8 inches.
 2. Parallel or Opposed]-blade design.
 3. Galvanized steel.
 4. 0.064 inch thick.
 5. Blade Edging: Closed-cell neoprene edging.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch- diameter; galvanized steel blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
1. Molded synthetic
 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 3. Thrust bearings at each end of every blade.

2.4 FIRE DAMPERS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. Arrow United Industries; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Greenheck Fan Corporation.
 5. McGill AirFlow LLC.
 6. METALAIRE, Inc.
 7. Nailor Industries Inc.
 8. NCA Manufacturing, Inc.
 9. PHL, Inc.
 10. Pottorff; a division of PCI Industries, Inc.
 11. Prefco; Perfect Air Control, Inc.
 12. Ruskin Company.
 13. Vent Products Company, Inc.
 14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 and 3 hours.

- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- K. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F rated.

2.5 FLANGE CONNECTORS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

1. TURNING VANES

- E. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. METALAIRE, Inc.
 4. SEMCO Incorporated.
 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- F. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- G. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- H. Vane Construction: Double wall.
- I. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.6 DUCT-MOUNTED ACCESS DOORS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Cesco Products; a division of Mestek, Inc.
 3. Ductmate Industries, Inc.
 4. Flexmaster U.S.A., Inc.
 5. Greenheck Fan Corporation.
 6. McGill AirFlow LLC.
 7. Nailor Industries Inc.
 8. Pottorff; a division of PCI Industries, Inc.
 9. Ventfabrics, Inc.
 10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
 - a. Double wall, rectangular.

- b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.7 DUCT ACCESS PANEL ASSEMBLIES

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Flame Gard, Inc.
 - 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.8 FLEXIBLE CONNECTORS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.

- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.9 FLEXIBLE DUCTS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004
- C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004
- D. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004
- E. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.10 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. On both sides of duct coils.
 2. Upstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. At each change in direction and at maximum 50-foot spacing.
 8. Upstream from turning vanes.
 9. Control devices requiring inspection.
 10. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- J. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment.
- L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- M. Connect terminal units to supply ducts directly without the use of flexible ducts.
- N. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

- O. Connect flexible ducts to metal ducts with draw bands.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

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SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.

1.2 PERFORMANCE REQUIREMENTS

- ~~A.~~ Structural Performance: Hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

1.3 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 1. Air terminal units.
 - 2. Liners and adhesives.
 - 3. Sealants and gaskets.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - 3. Hangers and supports, including methods for duct and building attachment,
- C. Delegated-Design Submittal:
 - 1. Materials, fabrication, assembly, and spacing of hangers and supports.
 - 2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified Licensed Professional Engineer responsible for their preparation for selecting hangers and supports and seismic restraints.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Size and location of initial access modules for acoustic tile.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- E. Field quality-control reports.
- F. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Anemostat Products; a Mestek Company.
 - 2. Carnes.
 - 3. Environmental Technologies, Inc.
 - 4. Krueger.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.
 - 7. Phoenix Controls Corporation.
 - 8. Price Industries.
 - 9. Titus.
 - 10. Trane; a business of American Standard Companies.
 - 11. Trox USA Inc.; a subsidiary of the TROX GROUP.
 - 12. Tuttle & Bailey.
 - 13. Warren Technology.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch steel, singlewall.
 - 1. Casing Lining: Adhesive attached, 3/4-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

- a. Cover liner with nonporous foil.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- 1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 - 2. Damper Position: Normally open
- E. Attenuator Section: 0.034-inch steel sheet.
- 1. Lining: Adhesive attached, 3/4-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
- a. Cover liner with nonporous foil.
 - 2. Lining: Adhesive attached, 3/4-inch- thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- F. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
- 1. Access door interlocked disconnect switch.
 - 2. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
 - 3. Nickel chrome 80/20 heating elements.
 - 4. Airflow switch for proof of airflow.
 - 5. Fan interlock contacts.
 - 6. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 - 7. Mercury contactors.
 - 8. Pneumatic-electric switches and relays.
 - 9. Magnetic contactor for each step of control (for three-phase coils).
- G. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 23 09 23 "Instrumentation and Control for HVAC."

- H. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Section 23 09 23 "Instrumentation and Control for HVAC" and shall have the following features:
 - 1. Damper Actuator: 24 V, powered closed, spring return open
 - 2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Occupied and unoccupied operating mode.
 - b. Remote reset of airflow or temperature set points.
 - c. Adjusting and monitoring with portable terminal.
 - d. Communication with temperature-control system specified in Section 23 09 23 "Instrumentation and Control for HVAC."
 - 3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
- I. Control Sequence:
 - 1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
 - 2. System-powered, wall-mounted thermostat.

2.2 HANGERS AND SUPPORTS

- A. Refer to Section 23 05 29, "Hangers and Supports for HVAC Piping and Equipment" for additional requirements.
- B. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- C. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
 - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units' level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: ~~Concrete inserts, powder-actuated fasteners, or~~ structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install cable restraints on air terminal units that are suspended with vibration isolators.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, ~~or to concrete members.~~

3.3 CONNECTIONS

- A. Connect ducts to air terminal units according to Section 23 31 13 "Metal Ducts."
- B. Make connections to air terminal units with flexible connectors complying with requirements in Section 23 33 00 "Air Duct Accessories."

3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Air terminal unit will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

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SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Linear slot diffusers.
 - 3. Adjustable bar registers and grilles.
 - 4. Fixed face registers and grilles.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers -
 - 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. A-J Manufacturing Co., Inc.

- b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Hart & Cooley Inc.
 - e. Krueger.
 - f. METALAIRE, Inc.
 - g. Nailor Industries Inc.
 - h. Price Industries.
 - i. Titus.
 - j. Tuttle & Bailey.
- 2. Devices shall be specifically designed for variable-air-volume flows.
 - 3. Material: Aluminum
 - 4. Finish: Baked enamel, white or black (coordinate with ceiling)
 - 5. Face Size: 24 by 24 inches and 12 by 12 inches (see schedule)
 - 6. Face Style: Three cone
 - 7. Mounting: T-bar or Duct mounted (see application)
 - 8. Pattern: Adjustable
 - 9. Dampers: Combination damper and grid
 - 10. Accessories:
 - a. Equalizing grid.
 - b. Sectorizing baffles.

2.2 CEILING LINEAR SLOT OUTLETS

~~A.~~ Linear Bar Diffuser

- 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Research Diffuser Products, Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. METALAIRE, Inc.
 - h. Nailor Industries Inc.
 - i. Price Industries.
 - j. Titus.
 - k. Tuttle & Bailey.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material: Aluminum.
- 4. Finish: Baked enamel, Black (match ceiling color)
- 5. Narrow Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/4 inch apart, zero deflection
- 6. Frame: 1 inch wide.

7. Mounting: Spring clip
8. Damper Type: Hinged single blade.

2.3 REGISTERS AND GRILLES

~~A.~~ Louvered Grille -

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. METALAIRE, Inc.
 - h. Nailor Industries Inc.
 - i. Price Industries.
 - j. Titus.
 - k. Tuttle & Bailey.
2. Material: Steel
3. Finish: Baked enamel, white or black (coordinate with mounting surface)
4. Face Blade Arrangement: Long Front Blades, double deflection, 3/4" Spacing
5. Rear-Blade Arrangement: Short dimension rear blade, 3/4" spacing
6. Frame: 1-1/4 inches.
7. Mounting: Countersunk screw
8. Damper Type: Adjustable opposed blade
9. Accessories:
 - a. Blade gang operator.

~~B.~~ Fixed Face Grille -

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. Nailor Industries Inc.
 - h. Price Industries.
 - i. Titus.

- j. Tuttle & Bailey.
- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white
- 4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid
- 5. Core Construction: Integral or removable
- 6. Mounting: Lay in

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

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SECTION 23 41 00 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pleated panel filters.
2. Front- and rear-access filter frames.
3. Side-service housings.
4. Filter gages.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
 3. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
 2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

- C. Comply with NFPA 90A and NFPA 90B.

1.4 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide one complete set(s) of filters for each filter bank.

PART 2 - PRODUCTS

2.1 PLEATED PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
 - 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AAF International.
 - b. Airguard.
 - c. Camfil Farr.
 - d. Columbus Industries, Inc.
 - e. CRS Industries, Inc.; CosaTron Division.
 - f. D-Mark.
 - g. Filtration Group.
 - h. Flanders-Precisionaire.
 - i. Koch Filter Corporation.
 - j. Purafil, Inc.
 - k. Research Products Corp.
 - l. Tri-Dim Filter Corporation.
- B. Filter Unit Class: UL 900, Class 2.
- C. Media: Interlaced glass or synthetic fibers or Cotton and synthetic fibers coated with nonflammable adhesive.
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Media shall be coated with an antimicrobial agent.
 - 3. Separators shall be bonded to the media to maintain pleat configuration.
 - 4. Welded wire grid shall be on downstream side to maintain pleat.

5. Media shall be bonded to frame to prevent air bypass.
 6. Support members on upstream and downstream sides to maintain pleat spacing.
- D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.
- E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- F. Capacities and Characteristics:
1. See design drawings for specific filter requirements.

2.2 FRONT- AND REAR-ACCESS FILTER FRAMES

- A. Framing System: Galvanized-steel framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and pre-punched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AAF International.
 - b. Airguard.
 - c. Camfil Farr.
 - d. Columbus Industries, Inc.
 - e. CRS Industries, Inc.; CosaTron Division.
 - f. D-Mark.
 - g. Filtration Group.
 - h. Flanders-Precisionaire.
 - i. Koch Filter Corporation.
 - j. Purafil, Inc.
 - k. Research Products Corp.
- B. Prefilters: Incorporate a separate track with spring clips, removable from front or back.
- C. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

2.3 SIDE-SERVICE HOUSINGS

- A. Description: Factory-assembled, side-service housings, constructed of galvanized steel with flanges to connect to duct or casing system.
1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. AAF International.
- b. Airguard.
- c. Camfil Farr.
- d. Columbus Industries, Inc.
- e. CRS Industries, Inc.; CosaTron Division.
- f. D-Mark.
- g. Filtration Group.
- h. Flanders-Precisionaire.
- i. Koch Filter Corporation.
- j. Purafil, Inc.
- k. Research Products Corp.

- B. Prefilters: Integral tracks to accommodate 2-inch- deep, disposable filters.
- C. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices and arranged so filter cartridges can be loaded from either access door.
- D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2.4 FILTER GAGES

- A. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 - 1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Airguard.
 - b. Dwyer Instruments, Inc.
 - 2. Diameter: 4-1/2 inches.
 - 3. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg or Less: 0- to 0.5-inch wg.
 - 4. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg or Less: 0- to 1.0-inch wg.
 - 5. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg or Less: 0- to 2.0-inch wg.
- B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Install filter gage for each filter bank.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- F. Coordinate filter installations with duct and air-handling-unit installations.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Operate automatic roll filters to demonstrate compliance with requirements.
 - 2. Test for leakage of unfiltered air while system is operating.
- D. Air filter will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.3 CLEANING

- A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 00

SECTION 23 63 13 - AIR-COOLED REFRIGERANT CONDENSERS

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, air-cooled condensers for outdoor installation.

1.2 SUBMITTALS

- A. Product Data: For each air-cooled condenser, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Schematic drawing, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Liquid and vapor pipe sizes.
 - 2. Refrigerant specialties.
 - 3. Piping including connections, oil traps, and double risers.
 - 4. Compressors.
 - 5. Evaporators.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air-cooled condensers to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-cooled condensers and are based on the specific system indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate location of refrigerant piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow)
 - 2. Carrier Corporation; Carrier Air Conditioning Div.
 - 3. Daikin
 - 4. Panasonic
 - 5. Hitachi
 - 6. McQuay International.
 - 7. Trane Co. (The); Worldwide Applied Systems Group.
 - 8. York International Corp.
 - 9. USA Coil & Air Inc.
- C. Description: All units shall be factory assembled, internally wired, and 100% run tested to check operation before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with ANSI-UL 1995 / CAN/CSA C22.2 No.236.
- D. Refrigerant: R-410A.
- E. Condenser Coil: Factory tested at 425 psig.
- F. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- G. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

2.2 MANUFACTURED UNITS

- A. General Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
1. The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and Part 5 (Controls). The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 2. Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
 3. Outdoor unit shall have a sound rating no higher than 65 dB(A) individually or 70 dB(A) twinned. Units shall have a sound rating no higher than 52 dB(A) individually or 54.5 dB(A) twinned while in night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
 4. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
 5. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.
 6. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.
 7. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 8. VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
 9. The outdoor unit shall be capable of guaranteed operation in heating mode down to -18°F ambient temperatures and cooling mode up to 126°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.
 10. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.

11. Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.
 12. While in hot gas defrost the system shall slow the indoor unit fan speed down to maintain a high discharge air temperature, systems that keep fan running in same state shall not be allowed as they provide an uncomfortable draft to the indoor zone due to lower discharge air temperatures.
 13. The outdoor unit shall be capable of operating in cooling mode down to -10°F with optional manufacturer supplied low ambient kit.
 - a) Low ambient kit shall be provided with predesigned control box rated for outdoor installation and capable of controlling kit operation automatically in all outdoor unit operation modes.
 - b) Low ambient kit shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
 - c) Low ambient kit shall be factory tested in low ambient temperature chamber to ensure operation. Factory performance testing data shall be available.
 14. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
 15. VRF four-legged outdoor unit mounting systems shall be provided by manufacturer. Stand shall be made from 7 gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451-06 standards. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.
- B. Unit Cabinet:
1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
 2. The outdoor unit shall be tested in compliance with ISO9277 such that no unusual rust shall develop after 960 hours of salt spray testing.
 3. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately.
- C. Fans:
1. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG external static pressure, but capable of normal operation with a maximum of 0.32 in. WG external static pressure via dipswitch.
 2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 3. All fans shall be provided with a raised guard to prevent contact with moving parts.
- D. Refrigerant Piping:
1. R410A refrigerant shall be required for systems.
 2. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

3. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.
4. All refrigerant piping must be insulated with ½” closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
5. Refrigerant line sizing shall be in accordance with manufacturer specifications.

E. Coil:

1. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.
2. Outdoor Coil shall be elevated at least 12” from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer’s in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12” of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basi of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.
3. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant finish. Uncoated aluminum coils/fins are not allowed.
4. The coil shall be protected with an integral metal guard.
5. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
6. Unit shall have prewired plugs for optional panel heaters in order to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.
7. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.

F. Compressor:

1. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.
2. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer’s that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.
3. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting “belly-band” type crankcase heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.
4. Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.

5. The compressor shall be equipped with an internal thermal overload.
 6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
 7. Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.
- G. Operating and Safety Controls: The power and control center shall be integral to the unit housing and rated equivalent to NEMA 3R. A separate access door shall be provided with an approved locking device. All electrical components contained in the panel shall be UL/CSA certified and labeled. The unit shall be complete with VFDs, fuses, relays, phase protection, terminals for main ON/OFF and step-down transformer. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch shall be factory installed for ON/OFF servicing. An electrical pipe chase for power and control feeding shall be provided next to the control panel. The Short Circuit Current Rating (SCCR) is 5kA rms symmetrical, 600V Maximum. GFI, lights, and switches shall be factory installed and wired to a common junction box. A separate power connection 120V/1 will be required.
1. Fan Cycling Control: Head pressure switches.
- H. Access Doors: Access doors shall be provided to facilitate quick and easy access. Access doors will be made from the same material as the unit casing and shall incorporate thermal break construction. Removable panels provided as required. Hinges shall be aluminum hinge type designed to open 180 degrees.
- I. Communication Interface Card: The microprocessor shall be capable of communicating with the following protocol language:
1. Bacnet MS/TP RS-485.
 2. The unit shall be an integral part of the system & control network and react to heating/cooling demand as communicated from connected indoor e control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.
 3. The outdoor unit shall have the capability of 4 levels of demand control for each refrigerant system based on external input.
- J. Required Additional Components:
1. Liquid line filter/dryer
 2. Vertical receiver with temperature relief device
 3. Hi pressure switch
 4. Hi and low-pressure transducers
 5. Hi/low pressure gauges
 6. Suction and liquid lines shutoff valves
 7. Suction line accumulators.
- K. Required Safety Devices:
1. Compressor lockout protection for internal or external overload
 2. Low pressure protection
 3. High pressure protection

4. Compressor reverse rotation protection.

L. Required Controls:

1. Automatic compressor lead/lag control
2. Compressor minimum off time (5 min)
3. Capacity control with variable speed compressors
4. Alarm relay output out to indicate when the unit is in alarm condition.

M. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz or 460 volts, 3-phase, 60 hertz per equipment schedule.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
4. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
5. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
6. Wiring type: Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
7. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output
8. Network wiring shall be CAT-5 with RJ-45 connection.

- O. Warranty: Warrant each product to be free from defects in material and workmanship under normal and proper use and will within twelve (12) months from date of start-up and not exceed eighteen (18) months from shipment, repair or replace any part which, when returned to our factory transportation charges prepaid, and upon inspection by manufacturer, proves to be defective. Minimum (7) seven-year compressor warranty shall be provided. All refrigeration parts, including compressors shall be installed in a closed vented service compartment separate from the condenser coil airflow. Each refrigeration system shall be factory tested.

2.3 MOTORS

- A. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add paragraphs below to suit Project.
- B. General requirements for motors are specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

3. The following components are compulsory and must be included in the condensing:
 - a. liquid line filter/dryer, vertical receiver with temperature relief device, hi pressure switch, hi and low-pressure transducers, hi/low pressure gauges, suction and liquid lines shutoff valves, suction line accumulators.
 4. The following safety devices are also compulsory and must be included in the condign unit:
 - a. Compressor lockout protection for internal or external overload, low pressure protection, high pressure protection and compressor reverse rotation protection.
 - b. Controls shall include: automatic compressor lead/lag control, compressor minimum off time (5 min), capacity control with variable speed compressors and alarm relay out to indicate when the unit is in alarm condition.
 5. All refrigeration parts, including compressors shall be installed in a closed vented service compartment separate from the condenser coil airflow.
- C. Source Quality Control
1. Verification of Performance: Rate air-cooled condensers according to ARI 460.
 2. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.
- D. Power & Safety Control
1. The power and control center shall be integral to the unit housing and rated equivalent to NEMA 3R. A separate access door shall be provided with an approved locking device. All electrical components contained in the panel shall be UL/CSA certified and labeled. The unit shall be complete with VFDs, fuses, relays, phase protection, terminals for main ON/OFF and step-down transformer.
 2. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch shall be factory installed for ON/OFF servicing. An electrical pipe chase for power and control feeding shall be provided next to the control panel. The Short Circuit Current Rating (SCCR) is 5kA rms symmetrical, 600V Maximum.
- B. Service Power & Lighting
1. GFI, lights and switches shall be factory installed and wired to a common junction box. A separate power connection 120V/1 will be required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled condensers.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install unit level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Install air-cooled condensers on concrete base. Concrete base is specified in Section 23 05 00 "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- C. Concrete Bases:
 - 1. Install dowel rods to connect concrete base to concrete slab. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
 - 2. For equipment supported on structural slab, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. Install roof-mounting units on equipment supports specified in Division 07.
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
- B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to machine to allow service and maintenance.
- D. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 23 23 00 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Perform electrical test and visual and mechanical inspection.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 6. Verify proper airflow over coils.
- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- C. Remove and replace malfunctioning air-cooled condensers and retest as specified above.
- D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
1. Inspect for physical damage to unit casing.
 2. Verify that access doors move freely and are weathertight.
 3. Clean units and inspect for construction debris.
 4. Verify that all bolts and screws are tight.
 5. Verify that controls are connected and operational.
- B. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
- C. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist. System start-up supervision shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in system configuration and operation. The representative shall provide proof of manufacturer certification indicating successful completion within no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittal.
- D. Measure and record airflow over coils.
- E. Verify proper operation of capacity control device.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain air-cooled condensers.

END OF SECTION 23 63 13

SECTION 23 73 13 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Variable-air-volume, air-handling units.

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of $L/200$ where "L" is the unsupported span length within completed casings.

1.3 SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Filters with performance characteristics.
- B. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Gaskets: One set(s) for each access door.
 - 2. Fan Belts: One set(s) for each air-handling unit fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Daikin Applied (Base Building) and Daikin Vision (Tower)
- B. Acceptable Source: : Subject to compliance with Substitution Procedures in Section 01 25 00 of contract specifications, manufacturers offering products that may be incorporated into the work include, but are not limited to, the manufacturers specified.

2.2 UNIT CASINGS (INDOOR)

- A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.
4. Factory Finish for Steel and Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
5. Casing Coating: Manufacturer's standard coating.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071, Type I or Type II.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:
 - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
3. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 72 inches.
4. Locations and Applications:

- a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panel.
 - d. Damper Section: Doors.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.
 - g. Retain subparagraph below to add service lights. Service lights add cost and are considered optional features.
5. Service Light: 100-W vapor proof fixture with switched junction box located outside adjacent to door.
- a. Locations: Each section accessed with door .

D. Condensate Drain Pans:

- 1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection..
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2004.
 - b. Depth: A minimum of 2 inches deep.
- 2. Formed sections.
- 3. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
- 4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - a. Minimum Connection Size: NPS 1.
- ~~5.~~ Pan-Top Surface Coating: Stainless steel pan: None / Other: asphaltic waterproofing compound.
- 6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

- E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.3 FAN, DRIVE, AND MOTOR SECTION

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

- a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- B. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
- C. Fan Shaft Bearings:
 - 1. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 120,000 hours according to ABMA 11.
 - 2. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.
- D. Belt Drives: N/A
- E. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch .
- F. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.
 - 2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
 - 5. Mount unit-mounted disconnect switches on exterior of unit.
- G. Variable Frequency Controllers:
 - 1. Refer to Section 26 29 23, "Variable Frequency Motor Controllers." Variable frequency drives for air handling units, pumps and cooling towers shall be obtained from a single manufacturer.

2.4 COIL SECTION

- A. General Requirements for Coil Section:
 - 1. Comply with ARI 410.
 - 2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - 3. Coils shall not act as structural component of unit.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, pleated extended-surface type. Refer to Section 23 41 00, "Particulate Air Filtration" for additional requirements.
2. Thickness: 2 inches.
3. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

C. Filter Gages:

1. 3-1/2-inch- diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 2.0-inch wg .
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.6 DAMPERS

A. Comply with requirements in Section 23 09 23 "Instrumentation and Control for HVAC."

B. Damper Operators: Comply with requirements in Section 23 09 23 "Instrumentation and Control for HVAC."

C. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

D. Combination Filter and Mixing Section:

1. Cabinet support members shall hold 2-inch- thick, pleated, flat, permanent or throwaway filters.
2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.7 Controls: Refer to Section 23 09 23, "Instrumentation and Control for HVAC.

2.8 CAPACITIES AND CHARACTERISTICS

- A. See design drawings for unit capacities and characteristics.

2.9 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.
- D. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for ~~steam~~, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- ~~A.~~ Equipment Mounting: Install air-handling units on concrete bases using elastomeric pads. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Section 03 30 00 "Cast-in-Place Concrete." Account for additional 8 hours of manufacturer's oversight for disassembly and re-assembly of the air-handling unit on the site to accommodate its installation in existing mechanical room.
 - 1. Minimum Deflection: 1/2 inch
 - 2. Install galvanized steel plate to equally distribute weight over elastomeric pad.
 - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 6. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4 ASTM B 88, Type M copper tubing unless noted otherwise. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 23 21 13 "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- F. Refrigerant Piping: Comply with applicable requirements in Section 23 23 00 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.
- G. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 13

SECTION 26 00 01 - GENERAL PROVISIONS FOR GOVERNMENT FURNISHED EQUIPMENT
(GFE)

PART 1 - GENERAL

1.1 SUMMARY

- A. Provisions specified in this Section apply to Division 26 Sections noted as Government Furnished Equipment (GFE). Contract drawings are diagrammatic only, and do not give fully dimensioned locations of various elements of work. Determine exact GFE locations from field measurements. PART 1 and PART 3 of Sections identified as GFE are for general product information only, unless noted otherwise. The Contractor shall install GFE equipment as directed in PART 3 of the applicable Sections.
- B. Provide the following Electrical Equipment and Systems:
 - 1. Physical placement and securing in place of GFE electrical equipment.
 - 2. Installation and termination of all power and control wiring and associated conduit in accordance with the contract drawings, manufacturer's recommendations, and GFE shop drawings.
 - 3. Special ancillary equipment not included with the product but required for installation shall be provided by the Contractor. Examples include lugs, connectors, vibration isolators, and metal covers. All ancillary equipment provided by the contractor must meet the requirements of such equipment as defined in the contract documents.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. National Fire Protection Association (NFPA)
 - 1. NFPA 70 (2017)..... National Electrical Code.
- C. Occupational Safety and Health Administration (OSHA)
 - 1. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).
- D. FAA Orders and Standards:
 - 1. FAA-STD-1217f..... Electrical Work, Interior
 - 2. FAA-STD-019e Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Electronic Equipment

1.3 DEFINITIONS

A. Government Furnished Equipment (GFE):

1. Equipment that is specified GFE throughout Division 26, will be furnished and delivered to the site by the Government as originally shipped and packaged by the manufacturer. The Contractor shall unload, handle, store, set in place, and secure electrical equipment identified as GFE. The Contractor shall also install this equipment as specified in the appropriate equipment Section.

1.4 ADDITIONAL REQUIREMENTS

- A. The Contracting Officer's Representative shall provide manufacturers' cut sheets and approved shop drawings to the Contractor showing exact dimensions of equipment, installation details, and operations and maintenance data for the GFE. The Contractor shall include this information in the project Operation and Maintenance manual as identified in Section 26 05 00, "Common Work Results for Electrical." The Contracting Officer's Representative will be responsible for all interfaces with the GFE manufacturers with regard to testing and training of GFE equipment.
- B. Electrical Distribution Equipment (EDE) - The Contractor shall obtain manufacturers' cut sheets and approved shop drawings showing exact dimensions of equipment, installation details, and operations and maintenance data for the GFE from the Contracting Officer's Representative (COR) 240 days after Notice to Proceed (NTP). The Contractor shall replace generic EDE equipment dimensions in the BIM with final shop drawing dimensions provided by equipment manufacturer. The Contractor shall include this information in Operation and Maintenance manual as identified in Section 26 05 00, "Common Work Results for Electrical." The Contracting Officer's Representative will be responsible for all interfaces with the GFE manufacturers with regard to testing and training of GFE equipment.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Perform work to meet or exceed the requirements of all referenced standards indicated in paragraph 1.2 and other applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction. Notify the Contracting Officer's Representative of known or probable code violations discovered during contract performance. Do not proceed with the work until violations have been resolved.

B. Manufacturer's Statement:

1. A manufacturer's statement indicating complete compliance with the applicable document is acceptable as proof of compliance.

C. Listing and Labeling Ancillary Equipment:

1. Electrical equipment and materials required to complete the installation of GFE equipment shall be UL-listed and labeled. The terms "Listed and Labeled" as defined in

NFPA 70, Article 100. Listing and labeling agency qualifications as defined in 29 CFR 1910.7.

D. Qualifications:

1. Installer shall have successfully completed within the last 3 years at least five projects similar in type and size to this project and shall be certified by the manufacturer. Names, locations, contacts, and phone numbers of these projects shall be provided with the submittals.

E. Installer Certification:

1. Submit written manufacturer's certification of the installer for said manufacturer's products.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. The GFE will be delivered to the Contracting Officer's Representative (COR) on site. The Contractor and the Contracting Officer's Representative must jointly inspect the equipment before Contractor acceptance. If equipment is deemed acceptable by both parties, the Contractor shall assume the responsibility of safely storing the equipment in a conditioned and dust free area. If required by the Contracting Officer's Representative, the Contractor shall furnish and install space heaters or provide desiccant recommended by the equipment manufacturer to prevent condensation. The Contractor shall conduct routine inspections and verify the condition of the stored equipment. The Contractor shall only use factory-installed lifting provisions.
- B. Adequate notice shall be given for the arrival of the following on site:
1. Engine Generator and Accessories – 8 months
 2. Automatic Transfer Switch – 8 months
 3. Electrical Distribution Equipment – 9 months
 4. Static Transfer Switches – 6 months
 5. Uninterruptable Power System – 3 months
 6. TVSS – 2 months

1.7 PROJECT CONDITIONS

- A. Verify dimensions by field measurements.
- B. Determine suitable path for moving equipment out of storage.
- C. Verify clearance requirements and locate equipment considering installation tolerances.
- D. Revise locations and elevations from those indicated as required to suit project conditions.
- E. Layout and coordinate work in advance and prior to any installation to avoid conflicts or interference with other work. Review BIM Model and coordinate with other disciplines before beginning installation. Maintain NFPA 70 (2017) working space clearances around electrical and communications equipment. Establish the exact location of electrical equipment based on the actual field verified dimensions of equipment furnished.

- F. Coordinate conduit rough-in locations into equipment with Government provided approved shop drawings and coordinated installation drawings for GFE. Submit conduit shop drawings for approval.
- G. Provide conduits, stub-ups, sleeves, anchor bolts, and other similar items to be cast into concrete. Protect open ends of conduit with appropriate conduit cap prior to pouring of concrete.
- H. Where unknown obstructions are encountered, notify the COR. Do not alter routing of work until approved by the COR.
- I. Electrical equipment sizes indicated on the drawings are generally based on specified manufacturer.
- J. Verify that the GFE proposed will fit in the space indicated on the drawings. Notify the COR immediately if space issues are identified. Coordinate building dimensions with architectural and structural drawings. Coordinate equipment furnished and installed under other Sections of the Specification with electrical equipment installed under this Section.
- K. Maintain clearances around electrical equipment as required by NFPA 70 (2017) and all applicable codes. Establish the exact location of electrical equipment based on the actual field verified dimensions of equipment furnished.
- L. Ensure that electrical work is coordinated and compatible with work shown on architectural, civil, mechanical and structural drawings.

1.8 COORDINATION

- A. Provide coordination drawings and BIM model in accordance with SECTION 01 40 10 - CONTRACTOR-PREPARED COORDINATION DRAWINGS.
- B. Layout Work from building and property lines and benchmarks provided, verify, and be responsible for the correctness of measurements in connection with Work. Change made to major overall dimensions shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to the use of equipment of a manufacturer other than that used as a basis of design shall cause no interference with other Work.
- C. Examine the BIM models and Drawings of other trades. Cooperate and coordinate with other trades to ensure that the Work can be installed properly as designed and planned without interference with other work or delay. Where interferences may occur and departures from arrangements shown are required, consult with other trades involved. Come to an agreement as to changes, locations, and elevations. Furnish all necessary templates, patterns, measurements, etc., for installation and for the purpose of making adjoining work conform. Furnish setting plans and shop details to other trades as required.
- D. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required may not be shown due to the small scale of the Drawings; provide such offsets, bends or other items as required to meet structural or finish condition.
- E. Coordinate and be responsible for the required clearances in shafts, chases, double partitions. Coordinate and cooperate with the trades responsible for constructing such spaces, together with

other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review BIM model and large-scale composite Drawings showing space requirements that exceed those shown.

- F. If work is installed before coordinating with other trades so as to cause interference with the work of other trades, or so as not to provide proper access for maintenance or repair, make necessary changes to correct the condition at no cost to the government.
- G. Arrange for conduit spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Confirm in BIM model that there is no conflict between electrical conduit, cable trays, and raceways with mechanical piping and ductwork.
- H. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- I. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- J. Coordinate connection of electrical services.

PART 2 - PRODUCTS

2.1 GOVERNMENT FURNISHED EQUIPMENT

A. General:

- 1. The GFE will be delivered to the Contracting Officer's Representative on site. The Contractor and the Contracting Officer's Representative must jointly inspect the equipment before Contractor acceptance. If equipment is deemed acceptable by both parties, the Contractor shall assume the responsibility of safely offloading and storing the equipment. During inspection, contractor shall maintain the integrity of the packing material and repackage GFE after inspection.

B. Ancillary Electrical Equipment:

- 1. Provide materials and equipment to install GFE. The Contractor is responsible for delivering a complete, safe, maintainable, supportable and fully functional system.

2.2 CONCRETE EQUIPMENT BASES FOR GFE

A. Forms and Reinforcing Materials, as specified in Section 03 30 00, "Cast-in-Place Concrete."

B. Concrete:

- 1. 3000 pounds per square inch, 28-day compressive strength as specified in Section 03 30 00, "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. The rules, regulations, and reference documents indicated shall be considered as minimum requirements and shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship when specified or when required by the contract drawings. Equipment shall be installed in a manner to provide proper working space, access, and space for removal of the equipment as required to suit intended application.

B. Workmanship:

1. Materials and equipment shall be installed in accordance with the contract documents and the recommendations of the manufacturer for conditions and applications shown. The installation shall be accomplished by skilled workmen regularly engaged in this type of work. Where required by local regulations, the workmen shall be properly licensed or certified.

C. Contract Drawings:

1. Where the electrical drawings schematically indicate the work, diagrammatically or otherwise, furnish and install equipment, material, and labor for a complete and proper installation of GFE. Ensure that the electrical work is coordinated and compatible with architectural, civil, mechanical and structural work.

D. Installation Drawings:

1. Install GFE in strict accordance with equipment installation drawings furnished by the Government.

E. Review Other Sections:

1. Review other Sections of Specification to determine electrical requirements for equipment specified under those Sections.

F. Minor Departures:

1. Minor departures from exact dimensions shown in electrical drawings will be permitted where required to avoid conflict and unnecessary difficulty in installation of dimensioned items when other requirements are in compliance. Obtain written approval from the Contracting Officer's Representative prior to implementing departures.

G. Concrete Pads and Bases:

1. Install concrete pads and bases according to requirements of Section 03 30 00, "Cast-in-Place Concrete."

H. Identification of GFE:

1. Comply with Section 26 05 53, "Identification for Electrical Systems," the contract drawings, and the following instructions. Attach an engraved nameplate using round head chrome plated brass screws, to the front of each piece of GFE identified in Schedule A. Clearly identify on the nameplate the voltage, phase, equipment served and fed from. Use the full name of the equipment, such as "Engine Generator"; do not abbreviate. Engrave nameplates as indicated up to a maximum of three lines.

I. Seismic Requirements:

1. Contractor shall install all electrical equipment in accordance with applicable seismic zone requirements. Contractor shall furnish and install pads per E/G manufacturer requirements under E/G skid before setting E/G. Comply with section 26 05 48, "Vibration and Seismic Controls for Electrical Systems".

3.2 REPAIRS AND RESTORATION

- A. Repair damage to utilities and other construction caused by installation of GFE and ancillary electrical materials and equipment.

3.3 FIELD QUALITY CONTROL

A. Access to Equipment:

1. Locate GFE to allow easy access during operation, repair and maintenance.

B. Waterproofing:

1. Make equipment and components exposed to the weather watertight and insect proof. Protect equipment and conduit openings with temporary plugs or caps, when work is not in progress and until installation is completed. Restore watertight integrity of waterproof barriers pierced during construction, including roofing and walls.

3.4 TESTING

- A. Contractor acceptance testing of GFE will be performed under Section 26 00 02, "Documentation, Testing, and Training Requirements for Government Furnished Equipment (GFE)." Government acceptance testing and demonstration of GFE will be performed by the Government. The Contractor shall have a representative on site during the Government's acceptance testing and demonstration of this equipment to witness the proceedings.
- B. Contractor shall include the GFE testing in the overall construction schedule. The Contracting Officer's Representative shall make arrangements for GFE testing by manufacturer's representatives. The Contractor shall notify the Contracting Officer's Representative 21 calendar days in advance to schedule dates.
- C. Prior to the Government's acceptance testing of GFE, the Contractor shall perform the following visual inspections:

1. Compare nameplates of equipment and detailed components with single-line diagrams and specified requirements, and report deficiencies and discrepancies to the Contracting Officer's Representative.
2. Check for proper anchorage, required clearances, physical damage, and proper alignment of electrical equipment and components.
3. Inspect equipment for working of movable parts, paint, and dents, scratches, proper fit and missing hardware.
4. Clean interior and exterior of equipment using manufacturer's approved methods and materials.

3.5 CLEANING

- A. After completing system installations, including fittings and devices, inspect exposed finishes. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by the manufacturer. Remove burrs, dirt and construction debris from the area.

3.6 DEMONSTRATION

- A. Procedures and schedules for start-up and shutdown troubleshooting, servicing and preventative maintenance will be directed under Section 26 00 02, "Documentation, Testing, and Training Requirements for Government Furnished Equipment (GFE)."

END OF SECTION 26 00 01

CONTRACTING OFFICER'S REPRESENTATIVE SECTION

26 00 02 - DOCUMENTATION, TESTING, AND TRAINING REQUIREMENTS FOR
GOVERNMENT FURNISHED EQUIPMENT (GFE) AND CONTRACTOR FURNISHED
EQUIPMENT (CFE)

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section defines documentation, testing, training, support, and supply requirements for Government furnished equipment (GFE) and Contractor Furnished Equipment (CFE). Testing procedures outlined in Part 3 of this Section shall not replace testing listed under other Sections of the Specification for GFE. Testing listed under this Section shall clarify or be performed in addition to testing requirements listed for GFE and CFE in other Sections of this Specification as noted herein. Testing procedures approved by the Commissioner's Technical Representative of all GFE is required whether specifically listed or not in this specification.
- B. GFE Requirements: Pre-functional tests. Assistance to the government vendor for functional tests, start-up, and commissioning. Testing of generator transfer schemes, load shed, fire pump interfaces to generator control panel and load restoration.
- C. CFE Requirements: Pre-functional tests, functional tests, start-up, commissioning, and training of FAA personnel.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Part One Instructions and Execution Documents, Part Two general Conditions, and Division 01 Specification Sections apply to this section.
- B. Section 260800 – Commissioning of Electrical Systems

1.3 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. Federal Standards (FS)
 - 1. FAA Order 6980.5a Engine Generator Transfer Procedures for Anticipated Power Failure
 - 2. FAA Order 6980.11c Maintenance of Engine Generators
 - 3. FAA Order 6980.29a Maintenance of Static Uninterruptible Power Supply (UPS)

- 4. FAA-D-2494..... Technical Instruction Book Manuscript: Electrical Equipment for Preparation of Manuscript and Production of Books.
 - C. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 43..... Recommended Practice for Testing Insulation Resistance of Rotating Machines.
 - D. National Fire Protection Association (NFPA)
 - 1. NFPA 70 (2017)..... National Electrical Code.
 - 2. NFPA 110 (2022)..... Standard for Emergency and Standby Power Systems
 - E. Occupational and Safety and Health Administration (OSHA)
 - 1. 29 CFR 1910.7..... Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).
 - F. FAA Standards
 - 1. FAA-STD-019e Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Electrical Equipment
 - 2. FAA-STD-1217f..... Electrical Work, Interior
 - G. UL 486A Wire Connections and Soldering Lugs for Use with Copper Conductors
 - H. Project plans and specifications.
- 1.4 DEFINITIONS
- A. Government Furnished Equipment (GFE):
 - 1. Equipment that is specified GFE throughout Division 26, will be furnished and delivered to the site by the Government as originally shipped and packaged by the manufacturer. The Contractor shall unload, handle, store, set in place, and secure electrical equipment identified as GFE. The Contractor shall also install this equipment as specified in the appropriate equipment Section. See 26 00 01 1.6 B for the required notification time for GFE system.
 - B. Contractor Furnished Equipment (CFE)
 - 1. All contact electrical components and systems which are not GFE.
- 1.5 SUBMITTALS
- A. The following shall be submitted in accordance with Section 01 33 00, "Submittal Procedures:"
 - 1. Manufacturer's Field Reports: Contractor shall submit two complete copies of field testing reports.

2. Other reports as called out in this section and the relevant division sections.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70 (2017).
- B. Testing Agency's Field Supervision:
 1. Person currently certified by the International Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies to supervise on-site testing. Testing agency shall have a minimum of 5 years prior experience.
- C. Field Testing Agency Qualifications:
 1. Independent testing agency shall meet 29 CFR 1910.7 criteria for accreditation of testing laboratories, or shall be a full-member company of NETA.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The successful implementation of the Air Traffic Control Tower requires the following elements of work from the contractor and from the government. The contractor will develop and present plans for approval to the Contracting Officer's Representative for each phase of activities 60 days prior to the intended start date of the activity. The contractor must ensure that he has read and understands all of the manufacturer's technical product literature and the requirements therein prior to beginning the following processes:
 1. Factory Witness Tests: The contractor representative is not required to attend Factory Witness Tests for GFE and CFE. The contractor will be provided with copies of the certified factory test and inspection reports for Government Furnished Equipment (GFE) and will be required to furnish for certain Contractor Furnished Equipment (CFE). The contractor is required to include factory test reports in their submittal of the record documents.
 2. Pre-Functional Testing: The responsibility for pre-functional testing is solely the responsibility of the contractor for both GFE and CFE. The purpose of the performance of pre-functional testing is to ensure that the individual components of a system required for a piece of apparatus to function in the manner intended meet the specified and manufacturer requirements and that the apparatus may be operated in a safe and efficient manner. The pre-functional testing is completed prior to the energization of apparatus and must include all specified, manufacturer recommended and regulatory tests as well as those listed in the various Division Section standards. Typical pre-functional testing includes but is not limited to the following typical items:
 - a. Insulation Resistance
 - b. Isolation Tests
 - c. Continuity Tests
 - d. Ground Resistance Tests
 - e. Torque Tests
 - f. Contact Resistance Tests
 - g. Communications Links

- h. Shunt trip operation
 - i. Load shed interfaces
 - j. Safety switch status inputs
 - k. EPMS peripheral operation
 - l. Setting of breakers and other protective devices
- 3. Functional Testing: Functional testing is solely the responsibility of the contractor for CFE. The contractor is encouraged to consult with the manufacturers prior to starting the work. The contractor is required to assist the government vendor for GFE functional testing.
 - a. The intention of functional testing is to ensure that each stand-alone apparatus or apparatus which is a component of a system functions in the manner as specified, as per manufacturer specifications and as required for safe and successful operation. It is the first time that apparatus is energized so extra safety precautions related to the operation of apparatus and as required by OSHA must be implemented. It also includes the tuning and setting of parameters to the conditions required for the application. Typical functional testing activities include but are not limited to:
 - 1) Tuning of VFD controllers.
 - 2) Ramping apparatus through their operating range and setting limits.
 - 3) Setting transformer taps
 - 4) Balancing Panel Loads
 - 5) Transfer switch operation
 - 6) Static transfer switch operation
 - 7) Battery Charger operation.
 - 8) Emergency generator auxiliary systems operation.
 - 9) Motor operations for all systems
 - 10) Lighting Control Systems
- 4. Start-Up: Start-Up is the responsibility of the contractor for CFE. The government is responsible for providing qualified factory technicians to perform the startup of GFE, the contractor is required to provide assistance as required. The purpose of startup is to ensure that factory certified technicians certify that apparatus has been installed and configured per factory requirements, that the apparatus is functioning as intended and that it is ready for service. Some elements of this work are repetitive to the functional testing requirements. The following apparatus require Start-Up:
 - a. Generator and all of its auxiliary apparatus.
 - b. Generator Load Bank
 - c. Transfer Switches
 - d. Static Transfer Switches
 - e. UPS
 - f. UPS Load Bank
 - g. Breaker trip functions
 - h. Fire Alarm System
 - i. Elevator
 - j. VFDs
 - k. EPMS

- l. Lighting Controls
 - m. Cathodic protection system
 - n. HVAC Systems
- 5. Commissioning:
 - a. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the FAA's operational needs; that the installation is adequately documented; and that the building system Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.
 - b. The contractor is responsible for creating the commissioning plans for CFE, implementing the plan and proving the reports and data required by the various specification sections.
 - c. Refer to section 260800 for commissioning requirements. The government is responsible for providing commissioning agents to create the commissioning plans for GFE and perform the work. The contractor is required to provide assistance to the commissioning agent as required to perform the work.

B. General:

- 1. Each GFE vendor will submit data (shop drawings, detail drawings, manufacturer's instruction manuals, O&M manuals) to the Contracting Officer's Technical Representative. The Contracting Officer's Representative will perform review and compilation of vendor data and then submit 5 copies to the Contractor for installation of the GFE.

2.2 DRAWINGS AND BIM MODEL

- A. Upon completion of the installation, the Contractor shall deliver three sets of as-built drawings and a copy of the complete BIM model to the Contracting Officer's Representative. One set shall be delivered on CD-ROM in Revit format. The other three sets shall be bond drawings sized 24 inches by 36 inches. BIM model and the set of drawings shall consist of the vendor installation drawing package corrected to show installation changes marked in red non-fading ink. These drawings shall show the final configuration of all wiring and equipment installed at the facility. These as-built drawings and BIM model shall be verified by the Contracting Officer's Representative on site.

2.3 MANUFACTURER'S INSTRUCTION MANUALS

- A. Contractor shall compile manufacturer's instruction manuals when required into indexed and alphabetized notebook binders. Each copy will be marked to show applicable choices and options. Where printed manuals include information on several products that are not required, copies will be marked to indicate the applicable information. The manufacturer's instruction manual will include at least the following sections:

1. Description of Equipment: Include size, weight, power consumption, power requirements, outline drawing.
2. Installation: Include methods, methodology for installing and interfacing the equipment, installation cautions, interface requirements, and typical installations.
3. Theory of Operation: Include a description of technical operating characteristics and individual equipment's using standard phraseology, descriptions of interface requirements including operating protocols, equipment displays and screens.
4. Operating Instructions: Include information instructions for operating the equipment in all of its modes of operation including interface displays and expected readouts in a self-help, self-teaching format.
5. Maintenance Requirements: Include manufacturer's recommended maintenance requirements and time schedules for accomplishing the maintenance for each part or item which requires maintenance.
6. Illustrated Parts List: Include exploded views of equipment with parts individually numbered and identified with a noun and uniquely numbered and referenced to a list of original equipment manufacturers' names and addresses.
7. Manufacturer Information: Include original manufacturers' names and addresses.
8. Manufacturer's Literature: Include manufacturer's literature on parts/subassemblies that are used within the system essentially unchanged for which the vendor does not have extensive development experience.
9. Drawings and Schematics: Include drawings and schematics for the equipment and may be referenced in previous Sections.
10. Troubleshooting Support Data: Commercial instruction books shall contain all needed data of this type to effect isolation and repair of faulty components. This data includes block diagrams, schematic diagrams, logic diagrams of required levels, functional and signal flows, power and its distribution, and photos or diagrams of cabinets, chassis modules, and printed circuit boards.

2.4 PRODUCT DATA

- A. Contractor shall compile GFE data when required into indexed and alphabetized notebook binders. Product data shall include printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves. Each copy will be marked to show applicable choices and options. Where printed product data includes information on several products that are not required, copies will be marked to indicate the applicable information. The following information shall be included:
 1. Manufacturer's printed recommendations.
 2. Compliance with trade association standards.
 3. Compliance with recognized testing agency standards.
 4. Application of testing agency labels and seals.
 5. Notation of dimensions verified by field measurement.
 6. Notation of coordination requirements.

2.5 TESTING PROCEDURES MANUAL

- A. The Contractor shall develop a Contractor's Master Test Plan as outlined in Part 3 of this Section. This test plan shall be submitted to, and approved by, the Commissioner's Technical Representative prior to commencing any field testing of the GFE.

2.6 FIELD TEST REPORTS AND FORMS

- A. Test reports shall be typed on field testing agency's preprinted tabular forms. Forms shall include formulas used in calculating values shown. Test reports shall document all discrepancies found during inspection and testing of equipment. The Commissioner's Technical Representative shall coordinate corrective action of discrepancies found with Contractor and GFE vendor.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. GFE vendors shall perform factory tests on GFE. The Contractor shall submit five copies of factory test reports to the Contracting Officer's Representative for each tested piece of equipment.
- B. A Contractor's representative shall be present for all factory testing. The COR shall provide one (1) copy of factory test reports to the contractor. The Contractor shall compile a consolidated set the test reports for each GFE equipment for inclusion with submission for the contractor acceptance inspection requirements indicated in Part 3.5 of this section.

3.2 FIELD TESTING AND INSPECTIONS

- A. Visual and Mechanical Inspection:
 - 1. Compare equipment nameplate information with drawings and specification.
 - 2. Inspect physical, electrical, and mechanical condition. Verify that cable and wire terminations are tight, that cables and wires are routed and dressed in an orderly fashion and relieved from strain.
 - 3. Check for correct anchorage, required area clearances, and correct alignment.
 - 4. Verify that fuse sizes and types correspond to drawings.
 - 5. Support GFE factory representative for testing of all electrical and mechanical interlock systems for correct operating and sequencing on GFE equipment.
- B. UPS Load bank Testing
 - 1. The contractor shall perform electrical testing for the generator load bank as follows:
 - a. Pre-functional and functional testing including but not limited to insulation testing.

2. Support the GFE factory representative in the performance of:

- a. Functional testing of the range of load capacity.
- b. Functional testing of blower operation.
- c. Functional testing of safety and protective devices.

C. Electrical Power Monitoring System (EPMS):

1. The contractor shall perform electrical testing and inspections for the EPMS as follows:
 - a. Verification of communications cables.
 - b. Verify point/point control and interrogation wires.
2. Support the GFE factory representative in the start-up of the EPMS system.

- D. For field testing and inspections of all other equipment, see individual equipment specification sections.

3.3 TEST RESULTS

- A. Contractor shall verify the following by testing and inspections and provide a test report which indicates compliance with requirements below to be completed prior to the GFE or CFE factory representative site visit. Factory recommended settings take precedence over Specifications in Contract Documents:

1. Insulation and continuity testing of all associated wires and cables.
2. Insulation testing of all apparatus main terminals.
3. Contact resistance checking all breakers, disconnect switches, transfer switches and static switches will be performed by the government vendor.
4. Ground testing of apparatus frame and ground bus.
5. Routing and tracing of Contractor furnished conductors is neat and orderly and free from strain.
6. Tagging, nameplates and warning labels installed.
7. All breaker settings in accordance with the approved short circuit and coordination study.
8. Bolt torque testing.

B. Circuit Breakers:

1. Circuit breaker test results shall conform to the following:
 - a. Bolt-torque levels shall be in accordance with Table A.9 unless otherwise specified by the manufacturer.
 - b. Insulation resistance shall not be less than 100 megohms.
 - c. Ratings and settings shall comply with the results and requirements of the short circuit and circuit breaker coordination studies performed for this project.

C. Static Bypass Switch:

1. Static bypass switch test results shall conform to the following:

- a. Bolt-torque levels shall be in accordance with Tables in this specification or UL 486A unless otherwise specified by the manufacturer.
- b. Insulation-resistance test voltages and minimum values shall be in accordance with Table A.5.
- c. Compare microhm values to adjacent poles and similar switches. Investigate deviations of more than 25 percent.

D. UPS Battery:

- 1. UPS battery test results shall conform to the following:
 - a. Bolt-torque levels shall be in accordance with manufacturer's published data. Contractor to test and provide data as part of the MasterTest report.
 - b. Specific gravity shall be in accordance with manufacturer's recommended values.
 - c. Electrolyte level shall be within normal limits.
 - d. Cell voltages shall be within 0.05 volt of each other or in accordance with manufacturer's published data.
 - e. Intercell resistance shall not vary by more than 25 percent for similar connections.
 - f. Cell impedance or conductance values shall not vary by more than 25 percent for identical cells that are in a fully charged state.

3.4 PACKAGED ENGINE GENERATOR SYSTEM

A. Tests listed shall clarify and be in addition to those specified in Section 26 00 02, Part 3.

B. Visual and Mechanical Inspection:

- 1. Compare equipment nameplate information with drawings and specification.
- 2. Inspect physical, electrical, and mechanical condition.
- 3. Check for correct anchorage, required area clearances, and correct alignment.
- 4. Test electrical and mechanical interlock systems for correct operation and sequencing.
- 5. Contractor shall provide manufacturer recommended fluids (oil and coolant) before startup.
- 6. Contractor shall fill new batteries with electrolyte and charge batteries according to manufacturer's recommendations.
- 7. Verify tightness of accessible bolted connections and/or cable connections by calibrated torque wrench.

C. Electrical and Mechanical Tests:

- 1. Perform an insulation-resistance test on generator windings with respect to ground in accordance with IEEE 43. Calculate polarization index. (Government vendor)
- 2. Test all protective relay devices. (Government vendor).
- 3. Perform phase-rotation test to determine compatibility with load requirements. (Government vendor)
- 4. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other features as applicable. (Government vendor)

5. Perform vibration baseline test. Plot amplitude versus frequency for each main bearing cap. (Government vendor)
6. Conduct performance test in accordance with NFPA 110, Section 5-13 (Installation Acceptance). (Government vendor)
7. Verify correct functioning of governor and regulator. (Government vendor)

D. Test Values:

1. Polarization index values shall be in accordance with IEEE 43. (Government Vendor)
2. Vibration levels shall be in accordance with manufacturer's published data or Table A.1. (Government vendor)
3. Performance tests shall conform to manufacturer's published data.

E. Verify operation of automatic transfer switches in accordance with the manufacturers written instructions.

1. Perform automatic transfer tests: (Contractor)
 - a. Simulate loss of normal power.
 - b. Return to normal power.
 - c. Simulate loss of emergency power.
 - d. Simulate all forms of single-phase conditions.
2. Verify correct operation and timing of the following functions (Contractor)
 - a. Normal source voltage-sensing relays.
 - b. Time delay upon transfer.
 - c. Alternate source voltage-sensing relays.
 - d. Automatic transfer operation.
 - e. Time delay and retransfer upon normal power restoration
3. Generator Load Bank Testing
 - a. Pre-functional insulation testing
 - b. Functional testing of the range of load capacity.
 - c. Functional testing of blower operation.
 - d. Functional test of safety and protective devices.

3.5 CONTRACTOR ACCEPTANCE INSPECTION (CAI)

- A. Upon completion of the installation and certification from the Contractor that the installation is complete in every respect, the Contractor shall assist the Commissioner's Technical Representative to perform a CAI on the GFE and perform CAI for CFE. This inspection shall include inspecting each equipment installation for proper mechanical and electrical installation, exercising the system in all possible modes of operation, checking and calibrating each system point, printing and displaying each system point, entering and deleting new points, and using any password systems. These tests shall be conducted in the presence of the Commissioners Technical Representative, who shall conditionally accept the system installation. Any training provided by the GFE and CFE vendors shall be conducted

prior to CAI. System performance testing will be performed by the Commissioners Technical Representative in conjunction with CAI.

3.6 TEST PLANS

- A. The Contractor shall submit a Contractor's Master Test Plan for GFE and CFE
- B. This document shall define the overall test philosophy and summarize all tests to be conducted. It shall describe methods for implementing and controlling the testing programs. The Master Test Plan shall require test performance reports to document the results of all tests. All test plans shall be reviewed by the Commissioner's Technical Representative before any testing can occur. Therefore, a test plan that describes the methods to be used for each system test shall be submitted at least 60 days before the scheduled test date. Include a step-by-step description of the tests, and indicate type and location of test apparatus to be employed. Demonstrate that the operation and installation requirements specified have been met.

3.7 TEST PROCEDURES

- A. A separate test procedure shall be prepared by the contractor for each test run to be conducted by the Contractor as identified in the Contractor's Master Test Plan. Test procedure shall include the detailed procedures and background information required for the conduct of a specified test run. The test procedures shall include the following:
 - 1. Title page,
 - 2. Location and schedule,
 - 3. References,
 - 4. Personnel and responsibilities,
 - 5. Equipment and computer program requirements,
 - 6. Test Operating Procedures,
 - 7. Detailed test descriptions,
 - 8. Detailed test verification,
 - 9. Recording and reduction requirements, and
 - 10. Data reduction and analysis procedures.

3.8 TEST PERFORMANCE

- A. Test performance reports shall be provided by the contractor for CFE and GFE which document the results of a test. They are used to identify and evaluate discrepancies between expect and actual test results. The test report shall contain the following:
 - 1. Identification of the specific test,
 - 2. Purpose of the test,
 - 3. Specific test objective,
 - 4. References to applicable test plan and procedure,
 - 5. Description of the test article,
 - 6. List of all test equipment,
 - 7. Description of the criteria used,
 - 8. Summary of test results,

9. Detailed test results,
10. Test evaluation, and
11. Certification that the test results are authentic, accurate, current, and in accordance with related requirements and test plans.

3.9 TRAINING

- A. The Contractor has no responsibility for personnel training for Government furnished equipment. The contractor is responsible for personnel training on Contractor furnished Equipment.

3.10 TABLE A.1

Maximum Allowable Vibration Amplitude

Speed - RPM Amplitude - Inches Peak to Peak

3000 and above	0.001
1500 - 2999	0.002
1000 - 1499	0.0025
999 and below	0.003

Derived from NEMA publication MG 1-1987, Sections 20.53, 21.54, 22.54, 23.52, and 24.50.

3.11 TABLE A.2

US Standard

Bolt-Torques for Bus Connections

Heat-Treated Steel - Cadmium or Zinc Plated

<u>Grade</u>		<u>SAE 1 & 2</u>	<u>SAE 5</u>	<u>SAE 7</u>	<u>SAE 8</u>
Minimum Tensile (PSI)		64K	105K	133K	150K
Bolt Diameter	In Inches	Torque (Foot Pounds)			
¼	4.0	5.6	8.0	8.4	
5/16	7.2	11.2	15.2	17.6	
3/8	12.0	20.0	27.2	29.6	
7/16	19.2	32.0	44.0	48.0	
½	29.6	48.0	68.0	73.6	
9/16	42.4	70.4	96.0	105.6	
5/8	59.2	96.0	133.6	144.0	
3/4	96.0	160.0	224.0	236.8	
7/8	152.0	241.6	352.0	378.4	
1.0	225.6	372.8	528.0	571.2	

3.12 TABLE A.3

Bolt-Torques for Bus Connections; Silicon Bronze Fasteners¹; Torque (Foot-Pounds)

<u>Bolt Diameter in Inches</u>	<u>Non-Lubricated</u>	<u>Lubricated</u>
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

¹ Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

Aluminum Alloy Fasteners²; Torque (Foot-Pounds)

<u>Bolt Diameter in Inches</u>	<u>Lubricated</u>
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

² Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

3.13 TABLE A.4

Bolt-Torques for Bus Connections

Stainless Steel Fasteners³; Torque (Foot-Pounds)

<u>Bolt Diameter in Inches</u>	<u>Uncoated</u>
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

³ Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

3.14 TABLE A.5

Insulation Resistance Tests on Electrical Apparatus and Systems

Maximum Rating of Equipment in Volts	Minimum Test Voltage In Volts (dc)	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
35,000	15,000	100,000
46,000	15,000	100,000
69,000	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the NETA Technical Committee suggests the above representative values.

3.15 PSG CPDS OT&E SCHEDULE

The below schedule shows the tasks and durations for testing and commissioning of TRACON and ATCT electrical systems, including electrical gears, generators, automatic transfer switches (ATS), uninterruptible power supplies (UPS) and battery monitoring system, static transfer switches (STS), electronics power monitoring systems (EPMS), and critical power distribution systems (CPDS). The contractor shall incorporate the below schedule into the overall master project schedule.

ID	Task Mode	Task Name	System	Responsible Party	Duration	Predecessors	Ma	S
1		PSG CPDS OT&E Schedule			78 days			
2		Building System Testing and Commissioning Process			71 days			
3		Pre-functional Testing Process			26 days			
4		Base Building Square D Electrical Gear Inspections	Electrical	PSG	5 days			
5		Tower Square D Electrical Gear Inspections	Electrical	PSG	5 days	4		
6		GEN & ATS Startups	Electrical	Kohler/PSG	4 days	5		
7		UPS Startups/Battery Service Test/Battery Monitor Startups	Electrical	Eaton/PSG	4 days	6		
8		STS Startups	Electrical	L-3/PSG	4 days	7		
9		Square D Gear Startups	Electrical	Sq D/PSG	4 days	8		
13		Functional Testing			45 days	3		
14		Base Building Electrical Installation Inspection	Electrical	ES/P SG/SSC/TSOG	5 days			
15		Tower Electrical Installation Inspection	Electrical	ES/P SG/SSC/TSOG	5 days	14		
16		EPMS Hardware Checkout	Electrical	PSG/Sq D	5 days	15		
17		EPMS Software Installation	Electrical	PSG/Sq D	2 days	16		
18		EPMS Software Phase 1 Testing	Electrical	PSG/Sq D	3 days	17		
19		Battery Baseline Testing	Electrical	PSG	5 days	18		
20		CPDS Electrical System Testing Phase 1	Electrical	PSG	5 days	19		
21		CPDS Standard Operating Procedure (SOP) Validation	Electrical	PSG/SSC/TSOG	5 days	20		
22		JAI Process			5 days	2		
23		EPMS Software Phase 2 Testing	Electrical	PSG/Sq D	5 days			
24		Commissioning Process			2 days	22		
25		CPDS Electrical System Testing Phase 2	Electrical	PSG	2 days			
26								

Project: PSG CPDS OT&E Standard
Date: Mon 3/18/13

Task

Split

Milestone

Summary

Project Summary

External Tasks

External Milestone

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only

Deadline

Progress

END OF SECTION 26 00 02

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SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. General:

1. The general electrical requirements in this section are applicable to both Government Furnished Equipment (GFE) and non-GFE. Materials and equipment shall comply with all requirements of the contract documents. Materials furnished by the Contractor shall be new, the standard products of manufacturers regularly engaged in the production of such materials, and of the manufacturer's latest designs that comply with the specification requirements. If material and equipment requirements conflict, the order of precedence for selection shall be as follows: special contract provision, this specification, the contract drawings; and then in continuing order of precedence, military specifications, federal specifications, NFPA publications, IEEE standards, UL standards and NEMA standards. Wherever standards have been established by Underwriters Laboratories, Inc., the material shall bear the UL label.
2. In addition to all submittal requirements indicated in this division, the contractor shall comply with all 3D BIM requirements indicated in Specification 01 40 10 "Contractor-Prepared Coordination Drawings."

1.2 REFERENCES

A. FAA Orders and Standards:

1. FAA-STD-1217f, ...Electrical Work, Interior
2. FAA-STD-1391B.....Installation and Splicing of Underground Cables
3. FAA-STD-019e, ...Lightning and Surge Protection, Grounding,
Bonding and Shielding Requirements for
Electronic Equipment

B. National Fire Protection Association (NFPA)

1. NFPA 70 (2017), ...National Electrical Code.
2. NFPA 110 Standard for Emergency and Standby Power
Systems
3. NFPA 780 Standard for the Installation of Lightning
Protection Systems

C. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE C2 National Electrical Safety Code
2. IEEE Std 100 Dictionary of Electrical and Electronics Terms

D. National Electrical Manufacturers Association (NEMA)

1. NEMA C57.12.28.....Pad-Mounted Equipment - Enclosure Integrity
2. NEMA ICS 6 Industrial Control and Systems Enclosures
3. NEMA MG 1 Motors and Generators
4. NEMA MG 10 Energy Management Guide for Selection and
Use of Fixed Frequency Medium AC Squirrel-
Cage Polyphase Induction Motors
5. NEMA MG 11 Energy Management Guide for Selection and
Use of Single-Phase Motors

1.3 ELECTRICAL CHARACTERISTICS

A. Provide the following electrical equipment and systems, but not limited to:

1. Equipment, wiring devices and electrical connections required for installation of electrical equipment.
2. Raceways and wiring for power and controls.
3. Grounding systems, including multipoint grounding systems.
4. Concrete equipment bases.
5. Cutting and patching for electrical construction.
6. Lightning protection system.
7. Excavation and backfill for underground utilities and services.
8. Seismic bracing.
9. Communications infrastructure and cabling.

B. Spacing Requirements:

1. Electrical equipment sizes indicated on the drawings are generally based on specified manufacturer. Verify that the equipment proposed will fit in the space indicated on the drawings. Coordinate building dimensions with architectural and structural drawings. Equipment furnished and installed under other Sections of this Specification shall be coordinated with the requirements of this Section. Maintain working clearances required by NFPA 70 around electrical equipment. Establish the exact location of electrical equipment based on the actual field verified dimensions of equipment furnished.

C. Departure from Dimensions Shown:

1. Minor departures from exact dimensions shown in electrical plans may be permitted when required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. The Contractor shall promptly obtain written approval from the Contracting Officer's Technical Representative prior to undertaking any such departures and shall provide appropriate documentation of the departure.

1.4 SUBMITTALS

A. Product Data: For each type of product specified.

- B. Samples: When the adequacy, quality and safety of a material will be better demonstrated and it will expedite approval, provide single samples of items proposed for use. Conform to the procedures specified. Submit samples of color, lettering style, and other graphic representation required for each identification product for the project.
- C. Test Reports: See individual specification sections for requirements.
- D. Operations & Maintenance Manuals: See individual specification sections for requirements.
- E. Coordination Drawings: See individual specification sections for requirements.
- F. Substitutions: Contractor shall submit in accordance with Section 01 25 00 "SUBSTITUTION PROCEDURES"

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70 and FAA-C-1217f for components and installation. In case of conflict between provisions of codes, laws and ordinances, the more stringent requirement shall apply.
- B. Material and Equipment Qualifications: Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.
- C. Listing and Labeling:
 - 1. Provide products specified in the Section that are listed and labeled. The terms "listed and labeled" as defined in the National Electrical Code, Article 100. Listing and labeling agency qualifications: NRTL as defined in 29 CFR 1910.7.
- D. Summary:
 - 1. Submit a summary of the Electrical Test Report and Motor Test Report, noting deviations from requirements listed below:
 - a. Maximum plus or minus 5 percent variation between nominal system voltage and no load voltage and between no load and full load voltage.
 - b. Variation between motor average phase current and measured individual phase currents does not exceed the manufacturer's specified limits.
 - c. Maximum plus or minus 20 percent variation between average phase current and measured individual phase currents for panelboards.
- E. Equipment Training (Non-GFE):

1. After final tests and adjustments have been completed, fully instruct the Contracting Officer's Technical Representative and other personnel, as directed by the Contracting Officer's Technical Representative in details of operation and maintenance of special equipment, including control system as installed. Submit outline of proposed instruction course 21 days prior to start for approval by the Contracting Officer's Technical Representative.

F. Project Record Documents

1. Maintain at the job site a separate set of white prints of the contract documents for the purpose of recording the system and dimension changes of those portions of work in which actual construction is at variance with the contract documents. The Contractor shall record changes for both GFE and Contractor provided equipment. Upon acceptance of the project, submit documents to the Contracting Officer's Technical Representative, with verification of data accuracy. Mark the drawings with colored pencil. Prepare the drawings as the work progresses. Upon completion of work submit drawings clearly indicating the following:
 - a. Locations of devices, conduits, equipment and other pertinent items. Indicate the depth of buried ducts and direct burial cable.
 - b. Schematic and interconnection wiring diagrams of the completed power and control system incorporating the data derived from the equipment shop drawings and the cable and conduit schedule. The drawings shall be detailed to wire and terminal block numbers, conductor color coding, device designations locations and reflect identifications established at the site.
 - c. Cable and conduit schedule for cables and conduits actually installed; include the type, size, origin, destination, and approximate length for each cable and conduit. Indicate for each cable the voltage rating, number of conductors, cable number, color coding and routing.

- G. Material and Equipment Manufacturing Date: Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 POSTED OPERATING INSTRUCTIONS

- A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 3. Safety precautions.
 4. The procedure in the event of equipment failure.
 5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.
- B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide

weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Contractor provided equipment shall be protected from damage and stored in a dry location from the time of site delivery. Furnish and energize space heaters or provide desiccant recommended by the equipment manufacturer to prevent condensation. Conduct routine inspections of stored equipment to check equipment condition.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate electrical equipment installation with other building components.
 - 1. Arrange for chases, slots and openings in building structure during progress of construction to allow for electrical installations.
 - 2. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
 - 3. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the work. Coordinate installing large equipment requiring positioning prior to closing in the building.
 - 4. Coordinate connecting electrical service to components furnished under other Sections.
 - 5. Coordinate connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
 - 6. Coordinate requirements for access panels and doors where electrical items requiring access are concealed by finished surfaces. Access panels and doors are specified in Division 8.
 - 7. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.
 - 8. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.
 - 9. Provide coordination drawings in accordance with SECTION 01 40 10 - CONTRACTOR-PREPARED COORDINATION DRAWINGS. Refer to BIM Model for required coordination.
- B. Interruption of Power:
 - 1. Contractor is advised that the project site is located at a fully operational airport. Unscheduled power interruptions to any of the electrical distribution systems are not allowed. Work requiring a temporary or permanent de-energizing of the electrical service shall be scheduled and approved in writing by the Contracting Officer's Technical Representative at least 14 calendar days in advance of performance of the work. Work may not commence until written authorization is received from the Contracting Officer's Technical Representative.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Channel and angle supports, raceway supports, sleeves and fasteners shall be as specified in Section 26 05 29, "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."

2.2 CONCRETE EQUIPMENT BASES

- A. Forms and reinforcing materials shall be as specified in Section 03 30 00, "CAST-IN-PLACE CONCRETE." Concrete shall be 3000 pounds per square inch, 28-day compressive strength as specified in Section 03 30 00, "CAST-IN-PLACE CONCRETE."

2.3 ELECTRICAL IDENTIFICATION

- A. Provide electrical identification as specified in Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS." Manufacturer's standard products to use colors prescribed by ANSI A13.1 and NFPA 70.
- B. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.4 SOIL MATERIALS

- A. See division 31 specifications for requirements on sub-base materials, and backfill and fill materials.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. All materials and equipment shall be installed in accordance with the contract drawings. Where manufacturer's recommended installation methods conflict with the contract requirements, difference shall be resolved by the Contracting Officer's Technical Representative. The installation shall be accomplished by skilled workers regularly engaged in this type of work. Where required by local regulation, the workers shall be properly licensed. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated. Install equipment to facilitate service, maintenance and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations. Give right of way to raceways and piping systems installed at a required slope.

3.2 EXCAVATION FOR ELECTRICAL WORK

- A. All excavations shall comply with OSHA requirements, Section 31 50 00, and Section 31 20 00. .
- B. Sediment and Erosion Control:
 - 1. Install sediment and erosion control measures in accordance with local codes and ordinances.
- C. Excavation for Underground Electrical Structures:
 - 1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10-foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction and for inspection. This includes trenching, installation and splicing or other joining of cables and testing of cables. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1-inch in diameter and larger with emulsified asphalt tree paint. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- D. Trenching:
 - 1. Excavate trenches for electrical installations as follows:
 - a. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
 - b. Excavate trenches to depth indicated or required.
 - c. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 - d. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations. The bedding material shall contain no particles that would be retained in a 1/4-inch sieve. Tamp the bedding material until firm.
- E. Cold Weather Protection:
 - 1. Protection excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F:
- F. Subsidence:
 - 1. Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions and replace surface

treatment. Restore appearance, quality and condition of surface or finish to match adjacent areas.

3.3 INSTALLATION

- A. The rules, regulations, and reference documents indicated shall be considered as minimum requirements and shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship than are specified or when required by the contract drawings. Equipment shall be installed in a manner to provide proper working space, access, and space for removal of the equipment to suit intended application.
- B. Contract Drawings:
 - 1. Where the drawings schematically indicate the work, diagrammatically or otherwise, furnish and install equipment, material and labor for a complete and proper installation. Ensure that electrical and communications work is coordinated and compatible with Architectural, Mechanical, Structural, and Civil work.
- C. Firestopping:
 - 1. Apply to cable and raceway penetrations of fire-rated floor and wall assemblies. Perform firestopping as specified in Section 07 84 13, "PENETRATION FIRESTOPPING" to re-establish the original fire resistance rating of the assembly at the penetration.
- D. Fastening:
 - 1. Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure in accordance with Section 26 05 29, "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."
- E. Concrete Pads:
 - 1. Install concrete pads and bases according to requirements of Section 03 30 00, "CAST-IN-PLACE CONCRETE."
- F. Identification Devices:
 - 1. Install identification devices where required in accordance with the requirements of Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
- G. Wiring Methods:
 - 1. All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.
- H. Conductor Routing:
 - 1. Panelboards, surge arresters, disconnect switches, etc., shall not be used as a raceway for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures.

I. Conductor Separation:

1. Power conductors shall be routed separately from all other conductor types. Route power conductors and other conductors in separate raceways, or by a metallic divider between the power conductors and the other conductors in the same raceway. 480Y/277V power cables shall be in separate raceways from 208Y/120V power cables.

J. Neutral Conductor:

1. Shared/common neutrals shall not be permitted (i.e., each overcurrent device shall have its own separate neutral conductor). Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.

K. Equipment Grounding Conductor:

1. Shared/common equipment grounding conductors shall not be permitted (i.e., each overcurrent protective device shall have its own separate equipment grounding conductor). The equipment grounding conductor shall be installed in the same conduit as its related branch and feeder conductors and shall be connected to the ground bus in the branch or distribution panelboard. Equipment grounding conductor shall be the same size as the phase conductors were indicated for special equipment branch or feeder circuits that require parity sized equipment grounding conductors to comply with equipment manufacturer's recommendations.

L. Cable Installation in Manholes or Handholes:

1. Power and control cables shall be installed in separate manholes or handholes unless otherwise shown on the drawings. Cable slack sufficient for one splice for each cable shall be left in each manhole.

M. Separation:

1. Where power and control cables share the same manhole, they shall be installed on opposite sides of the manhole. The entire exposed length of control, telephone and signal cables shall be fireproofed by applying a 1/4-inch minimum thickness of arc-proofing. Known acceptable source is 3M No. 7700 or approved equal.

N. Cable Racking:

1. Cables shall be carefully formed around the interior of manholes or handholes avoiding sharp bends or kinks. Splices and cables shall be tied to cable racks using 1/8-inch nylon line. Manhole cable racks and cable back arms shall be the plastic type provided with porcelain enamel insulators. Splices shall be a minimum of 2 feet from the mouth of the duct opening into the manhole. Splices in different cables shall be staggered.

O. Cable Terminations:

1. Provide terminations in accordance with this Section and manufacturer's requirements. All splices (including those in the building) must be approved by the Contracting Officer's Technical Representative.

- P. Provide Maxcell innerduct in underground communications conduits.
 - 1. White Polyester and Nylon resin polymer
 - 2. Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.

3.4 DEMOLITION

- A. Protect existing electrical equipment and installations when performing new work. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality. Remove demolished material from the project site. Remove, store, clean, re-install, reconnect, and make operational components indicated for relocation.
- B. Accessible Work:
 - 1. Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- C. Abandoned Work:
 - 1. Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish. All wire not removed shall have the Contracting Officer's Technical Representative's written approval.

3.5 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved. Repair disturbed surfaces to match adjacent undisturbed surfaces.

3.6 FIELD TESTING

- A. Perform the tests specified and other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system. Repair or replace equipment that does not meet test requirements and retest. Tests shall be scheduled and approved in writing by COTR at least 21 calendar days prior to conducting tests. Unless otherwise indicated, the Contractor shall furnish all test instruments, materials, and labor necessary to perform tests designated in Division 26 Sections. All tests shall be performed in the presence of the Contracting Officer's Technical Representative. All instruments shall have been calibrated within a period of 1 year preceding testing. Calibrations shall be traceable to applicable industry recognized standards.
- B. Interim Operating and Performance Test:
 - 1. Perform for each major equipment item after installation is complete and before the item is placed in service. After electrical systems have been completely installed, test each system for proper operation. Tests shall be conducted in the presence of the Contracting

Officer's Technical Representative under design conditions to ensure proper sequence of operation throughout different operating conditions. Make adjustments as required to ensure proper functioning of the systems. Special tests on individual systems are specified under individual Sections. Provide 21 days written notice to the Contracting Officer's Technical Representative for major tests. Contractor shall demonstrate, to the Contracting Officer's Technical Representative's satisfaction, proper operation of control devices by simulating actual operating conditions. Devices tested shall include, but not be limited to lighting, occupancy switches, dimming and shade systems, astronomical time clocks, photocells, emergency egress lighting, battery powered exit lighting, fire pump load shed, shunt tripping, GFCI receptacle and/or breakers, handicap door operators, multimedia devices, kitchen equipment, scissor lift, dampers/louvers, etc. Other larger GFE systems that shall be tested for proper functionality: EG, UPS, Load Bank, STS, Day tank, Fuel tank, breakers, etc.

C. Operation and Maintenance of Equipment:

1. After final tests and adjustments have been completed, fully instruct the Contracting Officer's Technical Representative and other personnel as directed by the Contracting Officer's Technical Representative in details of operation and maintenance of electrical equipment, including control systems and fire alarm system as installed.

D. Electrical Test Report:

1. Complete the Electrical Test Report included as Attachment No. 1. Provide the requested information for each panelboard and its power supply conductors. Perform insulation resistance tests in compliance with Section 26 05 19, "Low-Voltage Electrical Power Conductors and Cables" on wires including the neutral before connection to source and to loads. Perform the tests specified and other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system. Repair or replace equipment that does not meet test requirements and retest. Notify the Contracting Officer's Technical Representative in writing 21 days prior to conducting tests.

E. Motor Insulation Resistance Test:

1. The manufacturer shall provide the following requested information for each 3-phase electrical squirrel cage, induction motor 1/2-horsepower (HP) and larger supplied to this project. Complete the Motor Test Report included as Attachment No. 2. Motors shall be tested for grounds and short circuits prior to being shipped to the job site. Windings shall test free from short circuits and ground. Minimum insulation resistance for motors, phase to phase to ground, shall not be less than 30 megohm measured within a 500 volt DC insulation resistance tester. The manufacturer shall apply the test voltage for at least 1 minute after the reading has stabilized.

F. Electrical Main Supply and Distribution Feeders:

1. All electrical main supply and distribution feeders originating from switchboards, distribution panelboards, panelboards, or transformers, and all electrical feeders to 3-phase electrical squirrel cage, induction motor, 1/2-horsepower (HP) and larger, shall be tested for open/short circuits. All feeder circuit conduit shall be provided with grounding bushings. Submit the Electrical Test Report included as Attachment No.1.

G. Lighting, Power, Miscellaneous Power and Receptacle:

1. Lighting, power, miscellaneous power and receptacle single pole (1P) branch circuit panelboards, test any random 4 branch circuits (consisting of a phase conductor, a neutral and a grounding conductor) within a 42 pole panelboard or test one branch per every ten branch circuits. If more than 10 test points are above the specified value, then all branch line circuit wiring for both 120 volts and 277 volts shall be tested. Submit Attachment No.1, Electrical Test Report to the Contracting Officer's Technical Representative.

H. Other Tests:

1. All insulation resistance test, meggering, continuity tests, open and short circuiting testing that fail to meet the minimum standards as set forth in these electrical specifications shall have their feeder or branch circuit conductors (phase conductor, neutral and ground) removed and replaced. If after retesting, these feeder conductors fail to meet minimum requirements, the work shall be re-performed until such work and retesting passes the minimum design parameter requirements as set forth in these electrical specifications.

I. Circuit Breaker Tests:

1. No 120 volt, single pole (1P) 15-100 amp, or any 277 volt, single pole (1P), 15-150 amp, molded case circuit breaker is required to be tested. All two pole (2P) and all three pole (3P), molded case, insulated case and draw out power circuit breakers in both 208 volt and 480 volt ratings shall be tested for short circuit armature operation and for long term thermal overload protection operation to ascertain that they conform to within the manufacturer's recommended tolerances and design parameters. They shall be tested trip free of the handle operation, trip resetting and mechanical freedom of movement. The circuit breakers shall have factory recommended electrical insulation resistance and factory recommended electrical conductivity path resistance.

J. Receptacle and Miscellaneous Power Branch Circuit Test Procedures:

1. The following test procedures shall be used:
 - a. Open circuit the branch overcurrent circuit protection device (OCPD) and remove all plugs from all of the connected convenience receptacle outlets and devices. For switched receptacles and for single phase, thermal manual motor starters used with fractional horsepower (HP) supply and exhaust fan motors, close circuit the switch.
 - b. Then perform both the continuity test and insulation resistance meggering test. If the continuity and meggering test results are within specified design parameters, then disconnect all testing equipment and close the overcurrent circuit protective device (OCPD) / molded case branch circuit breaker. Otherwise repair the defective component and retest the branch circuit until satisfactory results are obtained.

K. Light Fixture Branch Circuit Wiring Test Procedures:

1. The following test procedures shall be used:

- a. For meggering test first open the overcurrent circuit protective device (OCPD), then close circuit for all light switches connected to the branch circuit prior to the first lighting fixture and then disconnect (open circuit) the branch circuit conductors from the first high intensity discharge (HID) or fluorescent lighting fixture in the circuit. Failure to do so can damage all lighting fixture ballasts in the circuit and will also give false low readings. A continuity test can be performed with all of the HID and fluorescent lighting fixtures connected, provided all of their respective light switches are open circuited and their OCPD is open circuited. Incandescent, Tungsten Halogen, Quartz Iodide and Halogen Iodide lamp lighting fixtures may be left in the circuit and be successfully tested for continuity and can be successfully meggered without any consequences.
- b. Then perform both the continuity test and then the insulation resistance meggering test. If the continuity and meggering test results are within specified design parameters then disconnect all testing equipment and close the overcurrent circuit protective device (OCPD) / molded case branch circuit breaker. Otherwise repair the defective component and retest the branch circuit until satisfactory results are obtained.

L. Load Balancing:

1. After the Contract Acceptance Inspection (CAI) of electrical systems, redistribute the loads where there is a greater than a 20 percent difference between readings in two or more phases, in accordance with Section 26 24 17, "Panelboards (GFE)."

ATTACHMENT NO. 1

Electrical Test Report

Project Name

Sheet No. _____ of _____

Date

Project No. _____ Address _____

SERVICE TRANSFORMER SIZE										
NL SERVICE VOLTAGE										
FL SERVICE VOLTAGE										
PANEL OR SWBD SERVED FROM										
PANEL OR SWITCHBOARD										
LOCATION										
MANUFACTURER										
TYPE										
FEEDER OC PROTECTION										
FEEDER CONDUCTOR SIZE										
GROUND CONDUCTOR SIZE										
MEASURED CONDITIONS	PHASE			PHASE			PHASE			
	A	B	C	A	B	C	A	B	C	
NO LOAD FEEDER VOLTAGE										
OPERATING LOAD FEEDER VOLTAGE										
OPERATING LOAD FEEDER CURRENT										
CONDUCTOR INSUL RESISTANCE Ø AB										
CONDUCTOR INSUL RESISTANCE Ø BC										
CONDUCTOR INSUL RESISTANCE Ø CA										
CONDUCTOR INSUL RESISTANCE TO GROUND										
NEUTRAL INSUL RES TO GR W/GR CONN REMOVED										

ATTACHMENT NO.2

Motor Test Report

Project Name

Sheet No. _____ of _____

Date

Project No. _____ Address

DESTINATION		
LOCATION		
HORSEPOWER		
NEMA STARTER SIZE		
STARTER MFG & CAT NUMBER		
HEATER CAT NUMBER		
MAXIMUM HEATER AMPS		
CONDUCTOR SIZE		
GROUND SIZE		
SERVED FROM PNL		

MEASURED CONDITIONS	PHASE				PHASE		
	A	B	C		A	B	C
ACTUAL MOTOR CURRENT							
NAMEPLATE MOTOR CURRENT							
NO LOAD VOLTAGE							
FULL LOAD VOLTAGE							
CONDUCTOR INSUL RESISTANCE Ø AB							
CONDUCTOR INSUL RESISTANCE Ø BC							
CONDUCTOR INSUL RESISTANCE Ø CA							
CONDUCTOR INSUL RESISTANCE TO GROUND							

END OF SECTION 26 05 00

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SECTION 26 05 05 - SUBMITTAL REQUIREMENTS FOR LOCKOUT/TAGOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section outlines the development of a comprehensive Lockout/Tagout (LO/TO) plan. Individual Lockout/Tagout procedures are to be created for all energized equipment not exempted by applicable codes and standards. Inventory of all energized equipment is also to be kept.

1.2 REFERENCE STANDARDS

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. Federal Standards (FS)
 - 1. FAA Order 3900.72 Lockout/Tagout Procedures—New Equipment Installation and Major Modifications
- C. National Fire Protection Association
 - 1. NFPA 70 (2021) National Electrical Code
- D. Occupational Safety and Health Administration (OSHA)
 - 2. 29 CFR 1910.147 The Control of Hazardous Material (Lockout/Tagout)
 - 3. 29 CFR 1910.333 Selection and Use of Work Practices

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, “Submittal Procedures:”
 - 1. Lockout/Tagout Procedures: Contractor shall submit three copies Lockout/Tagout procedures for all specified equipment prior to Substantial Completion. Procedures shall conform to the format of the attached worksheet and Part 3 of this section.
 - 2. Inventory of Facilities Evaluated for Lockout/Tagout: The Contractor shall submit three copies of an inventory of all energized equipment and systems prior to Substantial Completion.

1.4 QUALITY ASSURANCE

A. Contractor Qualifications

1. The Contractor completing the LO/TO procedures must have a minimum of five years experience in preparing such documentation.
2. The Contractor completing the LO/TO procedures must have completed a minimum of three projects similar in size and complexity.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 LO/TO PROCEDURE SHEETS

- A. LO/TO procedures shall adhere to all standards referenced in this section.
- B. The Contractor shall furnish all material, labor, and supervision to evaluate LO/TO hazards and the development of site specific written procedures and testing.
- C. The Contractor shall be responsible for the hiring and supervision of any Subcontractor, if necessary, to complete the actions specified herein.
- D. LO/TO procedure sheets shall contain the following information:
 1. Work Location: Location of equipment to be isolated, including equipment label and room number
 2. Equipment/Process: A brief explanation of this procedure including specific equipment names.
 3. Site Contact: Local FAA Technician (Coordinate with COR)
 4. Supervisor: SSC Manager (Coordinate with COR)
 5. PPE/Equipment Required: List of all required PPE/equipment as derived from the Arc Flash Study
 6. References: Equipment manuals and contract drawings that show the equipment
 7. Purpose: The goal of the form including safety reasons, giving specific equipment names.
 8. Energy Types: Locations and sources of energy related to the equipment's procedure (Check boxes for all that apply)
 9. Preparation for Shutdown: Review of isolation procedure, notification of employees in the area that the equipment will be shut down, and what coordination with Air Traffic is necessary
 10. Equipment Shutdown/Isolation: Step by step instructions detailing the disconnection of the equipment from its energy sources, including the application of proper lockout/tagout devices and tags at the appropriate locations.
 11. Verify Isolation of Equipment: Steps necessary to verify that equipment is de-energized. All necessary PPE must be worn while zero energy is verified.
 12. Release from LO/TO: Necessary steps to restore equipment to its original working state.

13. Procedure Written By: Name of contractor responsible for writing procedure.
14. Procedure Reviewed By: Authorized FAA representative. (Coordinate with COR)
15. Supervisor Signature: FAA SSC manager signature after witnessing each procedure. (Coordinate with COR)

3.2 INVENTORY OF FACILITIES EVALUATED FOR LOCKOUT/TAGOUT

- A. Contractor shall complete an inventory of all equipment that contains sources of energy. As-Built conditions must be taken into account while preparing the inventory. The inventory shall contain the following information:
 1. Equipment Type: Type of equipment and specific equipment names.
 2. Location: Location of equipment, including room number.
 3. Energy Sources: Type of energy sources feeding into each piece of equipment.
 4. Lockout/Tagout Device Necessity: Designation of whether a lockout/tagout device is necessary for each energy source. Include the type of device, if necessary.
 5. Energy Control Procedure Required: A brief description of the specific and general instructions for LO/TO, or the reason for exemption if no LO/TO procedure will be prepared.
- B. Inventory shall show which equipment requires and does not require LO/TO procedures to be written.
- C. Energy sources include sources of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

END OF SECTION 26 05 05

FAA – ESA LOCKOUT/TAGOUT PROCEDURE

Work Location:				Equipment/Process:	
Site Contact(s):				Supervisor:	
PPE/Equipment Required:				References:	
Purpose:					
Energy Types: Electric: ☐ Controls: ☐ Hydronic Water: ☐ Pneumatic: ☐ Refrigerant: ☐ Thermal: ☐ Gas: ☐ Domestic Water: ☐ Steam: ☐ Other: ☐					
Preparation for Shutdown: 1) 2) WARNING: The lockout / tagout actions outlined in this procedure do not supersede instruction found in any equipment technical order or instruction manual. Always review and perform all pre-requisite maintenance procedures before performing lockout / tagout.					
Equipment Shutdown/Isolation: Don protective equipment 3) 4) 5) 6)					
Verify Isolation of Equipment: 7) 8) 9)					
Release from LO/TO: 1) 2) 3) 4) 5) 6)					
Procedure Written by:				Procedure Re-viewed by (Authorized Person): 	
Supervisor Signature: 					
Date:		Phone:	Date:	Phone:	Date:
Phone:		Date:	Phone:	Date:	Phone:
Persons Authorized to Perform this Lockout/Tagout Procedure					
Name				Date Authorized	

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Inventory of Facilities Evaluated for LO/TO	

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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated volts and less.

1.2 REFERENCE STANDARDS

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. Federal Specifications (FS)
 - 1. FS QQ-W-343 Wire, Electrical, Copper (Uninsulated), with Notice 1
 - 2. FS W-S-610 Splice Connectors
- C. National Fire Protection Association (NFPA)
 - 1. NFPA 70 (2017)..... National Electrical Code
- D. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA WC3 Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 - 2. NEMA WC50 Ampacities, Including Effect of Shield for Single Conductor Solid Dielectric Power Cable 15kV through 69 kV
 - 3. NEMA WC70 Non-Shielded Power Cable 2000 V or Less
 - 4. NEMA WC71 Standard for Non-shielded Cables Rated 2001-5000 Volts
 - 5. NEMA WC74 5-46 kV Shielded Power Cable
- E. Underwriters Laboratories (UL)
 - 1. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - 2. UL 486C Standard for Splicing Wire Connectors
 - 3. UL 486E..... Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

F. American Society for Testing and Materials (ASTM)

1. ASTM B 8.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
2. ASTM D 1000 Standard Test Method for Pressure-Sensitive Adhesive-Coated Tapes used for electrical and electronic applications.

G. International Electrical Testing Association (NETA)

1. NETA ATS Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

H. National Electrical Contractors Association

1. NECA Standard of Installation

I. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."
- B. Test Reports: Field test reports indicating and interpreting test results relative to compliance with performance requirements of testing standard.
- C. Operation and Maintenance Data: Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.4 QUALITY ASSURANCE

- A. Testing Firm Qualifications: Testing shall be carried out by the electrical subcontractor.
- B. Components and Installation: Comply with NFPA 70 (2017), for components and installation.
- C. Listed and Labeled: Provide products specified in this Section that are listed and labeled. The terms "Listed" and "Labeled" as defined in NFPA 70 (2017), Article 100.
- D. Listing and Labeling Agency Qualifications: A NRTL as defined in 29 CFR 1910.7.
- E. Installer Qualifications: Cable splices shall be performed by experienced and qualified cable splices. The workman shall be licensed if required by the authority having jurisdiction.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate layout and installation of cable with other installations. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Contracting Officer's Representative.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

- A. Specified Applications: UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in PART 3.
- B. Rubber Insulation: Conform to NEMA WC3.
- C. Thermoplastic Insulation: Conform to NEMA WC70, NEMA WC71, and NEMA WC74. Shall be type THHN/THWN. Service entrance use SE cable only.
- D. Stranded Conductors: Solid copper conductor for 10 AWG and smaller; stranded copper conductor for larger than 10 AWG. Stranded conductors rating shall be tin coated, ASTM B 8, Class B.
- E. Wire and Conduit Sizes: All wire and conduit sizes are based on copper insulated conductors with 75 degrees C temperature rating and ambient temperature of 30 degrees C. Minimum conduit size shall be 3/4".
- F. Sizes: Minimum 12 AWG. Minimum 10 AWG for 120-volt circuits where circuit length (one way) exceeds 75 feet from source, and 10 AWG for 277 volt circuits where circuit length (one way) exceeds 150 feet from source. Communication systems wiring size shall be in accordance with manufacturer's requirements. Fire alarm and control systems wiring size shall be in accordance with manufacturer's requirements or as specified in Section 28 30 00, "MASTER FIRE ALARM SYSTEM."
 - 1. Stranded conductors shall be used with wire compression connectors or a pressure washer type lug.
 - 2. Conductor Type
 - 3. Soft drawn, annealed copper (aluminum conductors are not acceptable).
 - 4. Power conductors shall be single conductor type. (< #1/0 ; > #1/0 parallel cond. allowed)
 - 5. Control interconnection between equipment shall be jacketed type shielded multi-conductor.
 - 6. Instrumentation conductor shall be twisted pair, shielded, jacketed type.
 - 7. Conductors used for lighting and receptacle branch circuits shall be single conductor type.
- G. Conductor Color Codes: Refer to Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS" for conductors No. 4 AWG and larger, where factory color-coding is not available. Feeder conductors to panels and three phase circuits shall be factory color coded as follows:

1. 208/120 (240) Volt System:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral: White
 - e. Ground: Green
 2. 480/277 Volt System:
 - a. Phase A: Yellow
 - b. Phase B: Brown
 - c. Phase C: Orange
 - d. Neutral: Gray
 - e. Ground: Green
 3. Single-phase branch circuits shall be factory color coded as stated above, or identified in accordance with Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
 4. Control cables shall be IAW NEMA WC50
 5. DC power cables shall be as follows:
 - a. Plus: red color and identified with "+" symbol.
 - b. Minus: black color and identified with "-" symbol.
 - c. N: white (if used).
- H. Ground Conductors: Un-insulated conductors shall be copper and comply with FS QQ-W-343.
- I. Cables not permitted: AC cable, and SO cord.

2.2 CONNECTORS AND SPLICES

- A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for applications and for service indicated. Select to comply with project's installation requirements and as specified in PART 3.
- B. Connectors, Splice Sleeves, and Terminal Lugs: Wire and cable connectors, lugs, and sleeves shall be in compliance with UL 486A, and the following:
1. For splices of 10 AWG and smaller building wires in lighting circuits, use tin plated copper compression type connector caps with nonflammable, self-extinguishing insulation grip with temperature rating equal to that of conductor insulation.
 2. Use ring tongue compression type terminators with insulated barrel on all stranded conductors used in control wiring.
 3. Crimp type connectors are not permitted on solid conductors.
- C. Insulating Tape: ASTM D 1000. As a minimum, rate equal to conductor insulation. Rubber tape shall be silicon rubber with silicon pressure sensitive adhesive.
- D. Bundling Straps: Nylon straps with a locking hub or head on one end and a taper on the other.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceway and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Verify that the duct or conduit is open, continuous, and clear of debris before installing cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Feeders: Type THHN/THWN, copper conductor, in raceway.
- B. Indoor Branch Circuits: Type THHN/THWN, copper conductor in raceway. Use this conductor for lighting and receptacle circuits in dry locations only.
- C. Exterior Branch Circuits: Type THWN, copper conductor in raceway.
- D. Fire Alarm Power Circuits: Type THHN/THWN, copper conductor in raceway.
- E. Under Access Flooring Cable: Type THWN, copper conductor in flexible metal conduit with attached connectors.
- F. Communications System Wiring: Communications System wiring (to include telephone cable, fire alarm cable, security wiring, inter-communication wiring and public address/music system) shall be as specified under applicable sections and specified requirements of NFPA 70. Use shielded copper wire or fiber optics cable only. Aluminum wire is not permitted.
- G. Under-Floor Wiring: All under-floor wiring in air plenums of the raised floors must either be enclosed in raceway or be plenum-rated.
- H. Service Entrances: Type XHHW/XHHW-2 conductor rated for SE, USE or USE-2, single conductors in raceway.
- I. Emergency circuits: 2 hour fire rated Lifeline RHW (or equal), includes: all FLS circuits, elevator feeder from ATS, stair pressurization fan feeder, fire pump feeders (both sources), all EG start signals (included elevator, fire pump, building ATS's), fire life safety ATS feeder, and tower stairwell lighting.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.
 - 1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation, and must be non-flammable.
 - 2. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

3. Bend to radii not less than the minimum bending recommended by manufacturer or 12 times the outer diameter of cable. Do not exceed the pulling tension recommended by manufacturer.
 4. All box connectors shall have insulated throat box connector.
- B. Cable shall be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation or damage to the outer protective covering. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible. The ends of cables shall be sealed with moisture-seal tape before pulling, and it shall be left sealed until connections are made.
- C. Conductor Splices: Keep to a minimum.
- D. No splices shall be allowed on critical circuits and feeders or in any square wireway (essential or critical). No splices shall be allowed on any FLS circuits.
- E. Splices shall only be made only at outlets and junction boxes.
- F. Wire nuts may only be used to splice conductors sized No. 10 AWG and smaller.
- G. Compression connectors shall be used to splice conductors No. 8 AWG and larger.
- H. All splices, including those made with insulated wire nuts, shall be insulated with heat-shrink tubing to a level 1.5 times the factory insulated conductors.
- I. Splicing of any conductors in panelboards is not permitted.
- J. Splices shall be made with solderless connectors conforming to UL 486A, UL 486C, UL 486E and FS W-S-610.
- K. Install splices and insulating tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- L. Use splice and tap connectors that are compatible with conductor material.
- M. Splice methods and material shall be of a type recommended by the manufacturer of the splicing material for the particular type of cable being spliced and shall be approved by the Contracting Officer's Representative prior to installation.
- N. Wiring at Outlets: Install with at least 6 inches of slack conductor at each outlets.
- O. Connecting Outlets and Components: Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.
- P. Critical Circuits: Conductors for critical circuits, FLS bus circuits; emergency lighting, security systems, and fire alarm systems shall be kept completely independent from any other system as well as each other.

- Q. Cable/Conductor Installation: Cables/Conductors sized 250 kCMIL and greater shall be installed with the use of a hydraulic cable bender. Cable supports shall be required for stress relief. A splice shall not be pulled into a duct or conduit under any circumstance.
- R. Neutral and Ground: Separate neutral and ground wires shall be provided for each over current protection device. Each branch circuit shall have its own neutral and ground conductor. Common neutral or ground is not acceptable. Neutral conductors shall extend from the neutral bus where the phase conductors originate. Install conductors only after the raceway system is complete.
- S. Electrical Identification: Install electrical identification devices specified in Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS" at terminations, immediately after installing wires and cables.

3.4 FIELD QUALITY CONTROL

- A. Testing, General:
 - 1. Cables shall be tested prior to installation and again upon completion of the installation. Testing shall be accomplished before connection is made. Tests shall be performed in the presence of the Contracting Officer's Representative.
 - 2. Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 3. Perform each visual and mechanical inspection and electrical test state in NETA ATS. Certify compliance with test parameters.
 - 4. Test wire and cable for continuity or circuitry, and also for short circuits.
 - 5. Perform Facility Neutral/Ground Isolation Testing per FAA-C-1217F Appendix. Provide 3 copies of test results to COR.
- B. Insulation Resistance Tests: Feeder and branch circuit insulation tests shall be performed after installation, but before connection to equipment.
 - 1. Conductors shall test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 mega-ohms when measured with a 500-volt DC insulation resistance. The Contractor shall submit a letter type test report to the COR prior to final inspection of the work. The report shall list the tests performed and results obtained.
 - 2. Apply the test voltage for at least one minute after motor reading has stabilized.
- C. Malfunctioning Products: Correct malfunction products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

ATTACHMENT

Megger Test Report:

600 V CABLE INSULATION AND CONTINUITY TEST (power/control wire & cable)

Project Name _____ Date _____ Sheet No. _____ of _____

Project No. _____ Address _____

NOTE: 500 VOLT MEGOHMETER, MEGGER ALL PHASES, RECORD MINIMUM READING

Panel No. Ckt. No. Feeder No.	VOLTS	A-B	A-C	B-C	A-N	B-N	C-N	A-G	B-G	C-G	N-G	Supervisor O.K.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. FAA Specifications and Standards
1. FAA-STD-19e Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment
 2. FAA-HDBK-010 Recommended Practices and Procedures for Lightning and Surge Protection, Grounding, Bonding, and Shielding Implementation (April 11, 2013)
 3. FAA-HDBK-011 Fundamental Considerations of Lightning and Surge Protection, Grounding, Bonding and Shielding
- C. National Fire Protection Association (NFPA)
1. NFPA 70 (2017)..... National Electrical Code
 2. NFPA 780 (2020)..... Standard for the Installation of Lightning Protection Systems
- D. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE 81 (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- E. Underwriters Laboratories (UL)
1. UL 467 Grounding and Bonding Equipment
 2. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
- F. American Society for Testing and Materials (ASTM)

1. ASTM B 3.....Standard Specification for Soft or Annealed Copper Wire
2. ASTM B 33.....Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
3. ASTM B 8.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

G. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7.....Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

1.3 SUMMARY

- A. This Section includes solid grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of this Specification. Grounding requirements for FAA-occupied spaces often exceed NFPA 70 criteria. Install grounding systems in accordance with this Section and as indicated on the drawings. Lighting protection requirements are found in Section 26 41 13 "LIGHTNING PROTECTION FOR STRUCTURES" of this specification.

1.4 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES:"
- B. Product Data:
1. Grounding Rods
 2. Connectors and Connection Materials
 3. Grounding Fittings
 4. Qualifications
 5. Qualification data for firms and persons specified in "QUALITY ASSURANCE" article to demonstrate their capabilities and experience. Include lists of complete projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- C. Test Reports:
1. Field Tests and Observation Reports: Certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.
- D. Operation and Maintenance Data: Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: A nationally recognized testing laboratory as defined by 29 CFR 1910.7, or a full member company of NETA.
- B. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in PART 3. Comply with NFPA 70 (2017) and UL 467.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled as defined in NFPA 70 (2017), Article 100.
 - 1. Listing and Labeling Agency: Qualifications as defined in 29 CFR 1910.7.
- D. FAA RE shall be the authority conducting quality assurance on grounding.

PART 2 - PRODUCTS

2.1 WIRING AND CABLE GROUNDING CONDUCTORS

- A. Comply with Section 26 05 19, "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES." Conform to NFPA 70 (2017), except as otherwise indicated for conductor properties, including stranding.
- B. Material: Copper. Use only copper wire for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- C. Size: Comply with FAA-STD-19e.
- D. All feeder circuits for power panels shall have their equipment grounding conductor connect to a ground bushing.
- E. Isolated Grounding Conductors: Insulated with green color insulation and yellow and red bands.
- F. Electronic Multipoint Ground System: Insulated; color shall be green with bright orange tracer. Where cables are concealed and not color coded, any exposed portion of the cable and each end of the cable for a minimum of 2 feet shall be color coded by green tape overlaid with bright orange tape to form the tracer. Where routed through raceways or wireways, or under raised floors, the color coding shall be such that by removing or opening any cover, color coding shall be visible. Where conductors are routed through cable trays, color coding for a minimum length of 4 inches shall be accomplished at intervals not exceeding 3 feet between codings.
- G. Grounding-Electrode Conductors (GEC): Stranded copper cable. Insulated in PVC conduit for panel board or switchboard (see drawings for GEC connection requirements. .
- H. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- I. Bare Copper Conductors: Conform to the following:

1. Solid conductors: ASTM B 3.
2. Assembly of stranded conductors: ASTM B 8.
3. Tinned conductors: ASTM B 33.

- J. All grounding conductors that enter or exit concrete shall be provided with PVC conduit sleeve for protection.

2.2 MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper. Size as indicated on drawings.
- B. Braided Bonding Jumpers: Where electrical continuity across the shock mounts is necessary, bonding jumpers shall be installed across each shock mount. Jumpers of this application should have a maximum thickness of 0.025-inch, so that the damping efficiency of the mount is not impaired. In severe shock and vibration environments, solid straps may be corrugated, or flexible wire braid may be used. Braids are to be terminated with copper ferrules.
- C. Raceway Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted. Meet complete requirements of FAA-STD-019e paragraph 4.2.6.4.2.
- D. Panel board and Switchboard Grounds: Size grounding electrode conductor per NEC Table 250.66 minimum. Color code green. Run conductor in PVC pipe to building steel.

2.3 CONNECTOR PRODUCTS

- A. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.4 GROUNDING ELECTRODES AND ACCESS WELLS

- A. Grounding Rods: Grounding rods shall be copper or copper-clad steel, a minimum of 10 feet in length and 3/4-inch in diameter. Rod cladding shall not be less than 1/100-inch thick. Sectionalized type or exothermic butt welded rods shall be used when deeper earth penetration is required. Ground rods shall bear the manufacturer's name, trademark, and catalog number.
- B. Access Wells: Access wells are required at facilities. Locate wells as indicated on drawings. A minimum of two ground wells shall be installed if not shown on drawings at the Main Service Entrance, and at the Electronics equipment room. The access well shall have a minimum opening area of 175 square inches. The access well shall be provided with a removable locking cover with raised 3/4" lettering: "GROUND". Access wells shall be made from poured concrete, and have a removable cover. Cover shall be traffic-rated. Provide a minimum clearance (12 inches radius) from the center of the ground rod to the inside wall of the access well to allow ground rod connections to be readily inspected. The opening shall equal or exceed the minimum clearance required for the access well. All connections shall be by exothermic-weld process.

2.5 ELECTRONIC MULTIPOINT GROUND SYSTEM (MPG)

- A. The electronic multipoint ground system is a network which provides multiple low impedance paths between various non-current carrying metal objects in facility, electronic equipment (chassis), and the earth electrode system. This system is intended to minimize the effects of spurious currents that may be present in the ground system due to equipment operation or malfunction, or from lightning discharges. The multipoint ground system shall not be used in lieu of the safety ground required by NFPA 70. The multipoint ground system is not to be used as a signal return path.
- B. Multipoint Ground Plates and Buses: The location of the ground plate shall be chosen to facilitate the interconnection of all equipment enclosures, consoles, cabinets, racks, cases, etc., within a particular area. The distance from any ground plate to the specific individual equipment enclosure, console, rack, etc., being bonded to the MPG system shall never exceed three feet. Where more than one ground plate is necessary, they shall be installed at various locations within the facility to facilitate interconnection. Ground buses may be used when distributed grounding is desired or is more convenient with a long row of equipment cabinets – considering the requirement to be within three feet of the enclosure. Ground plates shall be copper and at least 12 inches long, 6 inches wide and 1/4 inch thick. Ground buses shall be copper. Ground bus width and thickness shall be selected from Table-I, and shall be as long as required. Ground plates and buses shall be identified with a permanently attached plastic or metal label that is green with distinguishing bright orange slashes. The label shall bear the caption “ELECTRONIC MULTIPOINT GROUND SYSTEM” in black 3/8-inch (10 mm) high letters. Plate widths shall be as followed: Main = 24” Multi = 12” Console = 6”
- C. Ground Conductors – Earth electrode System to Plates: Conductors in the MPG system shall be insulated and sized in accordance with Table-I, based on the distance between the Earth Electrode System and the furthest plate along any single path - but in no case smaller than 4/0 AWG. Conductors shall be color-coded green with an orange tracer or shall be clearly marked for four inches at each end and wherever exposed with green tape and an orange tracer. Additionally, when routed in cable trays, conductors shall be color-coded every three feet. Where MPG conductors are routed through cable trays, they shall be separated from the other conductors as far as possible.
- D. Structural Steel Bonding and Electronic Ferrous Shielding: Bond building structural steel at all locations around the perimeter of an electronic equipment room to the nearest MPG system location – and to the earth electrode system with 4/0 AWG conductors. All conduits, wireways, pipes, cable trays, or other metallic elements that penetrate these areas shall be bonded to the MPG system where they enter the area and every 25 feet for their entire length within the area. All conduits, wireways, pipes, cable trays, or other metallic elements within 6 feet of the MPG system shall be bonded to the MPG system. These bonds shall be made with 2 AWG conductors minimum.
- E. Carpet Grounding: Coordinate carpet grounding requirements with Section 09 68 13 “TILE CARPETING”. Provide ground connection for carpet flooring. Provide copper foil conductor (0.5 inch wide x 26 gauge thick) from carpeting to 2.625 wide X 3.625 heavy gage stainless steel ground plate, and #6 ground wire to multi-point ground bus. Provide (4) copper foil connection per 1,000 square feet of carpet per floor. All grounding shall be installed with conductive adhesive. Measured resistivity to ground shall be less than 10 ohms.

- F. Vinyl Tile Grounding: Coordinate vinyl grounding requirements with Section 09 65 36 "STATIC-CONTROL RESILIENT FLOORING". Provide ground connection for vinyl flooring. Provide copper foil conductor (0.5 inch wide x 26 gauge thick) from carpeting to 2.625 wide X 3.625 heavy gage stainless steel ground plate, and #6 ground wire to multi-point ground bus. Provide (4) copper foil connection per 1,000 square feet of tile per floor. All grounding shall be installed with conductive adhesive. Measured resistivity to ground shall be less than 10 ohms.

TABLE - 1 Size of Electronic Multipoint Ground Interconnecting Conductors

Conductor Size	Max. Path Length		Bus Bar Size		Max. Path Length	
	Ft.	(m)	Inch	(mm)	Ft.	(m)
750 kcmil*	375	(114.3)	4 x 1/4	(100 x 6.4)	636	(193.9)
600 kcmil*	300	(91.4)	4 x 1/8	(100 x 3.2)	318	(96.9)
500 kcmil	250	(76.2)	3 x 1/4	(75 x 6.4)	476	(145.1)
350 kcmil	175	(53.3)	3 x 1/8	(75 x 3.2)	238	(72.5)
300 kcmil	150	(45.7)	2 x 1/4	(50 x 6.4)	318	(96.9)
250 kcmil	125	(38.1)	2 x 1/8	(50 x 3.2)	159	(48.5)
4/0 AWG	105	(32.0)	2 x 1/16	(50 x 1.6)	79	(24.1)
3/0 AWG	84	(25.6)	1 x 1/4	(25 x 6.4)	159	(48.5)
2/0 AWG	66	(20.1)	1 x 1/8	(25 x 3.2)	79	(24.1)
1/0 AWG	53	(16.2)	1 x 1/16	(25 x 1.6)	39	(11.9)
1 AWG	41	(12.5)				
2 AWG	33	(10.1)				
4 AWG	21	(6.4)				
6 AWG	13	(4.0)				

Table Notes:

* Where these conductors are not available, parallel conductors shall be allowed, such as three 250 kcmil conductors in place of one 750 kcmil conductor, or two 300 kcmil conductors in place of one 600 kcmil conductor. The conductor sizing is based on providing a cross-sectional area of 2000 circular mils per linear foot. The bus bar sizes are chosen from available cross sections and exceed the cross-sectional requirement of 2000 circular mils per linear foot.

2.6 POWER DISTRIBUTION SYSTEM GROUNDING

- A. The facility electrical grounding shall comply with NFPA 70. The electronic ground systems shall not replace or be used in lieu of the power distribution system grounding conductors.

2.7 ATCT POWER DISTRIBUTION SYSTEM GROUNDING

- A. Good High Frequency Grounding: In order to assure good high frequency grounding during normal operation a low impedance connection must be provided to the earth electrode system

(EES). A main ground plate shall be established on the lowest level with electrical, electromechanical, or electronic equipment serving the ATCT Cab. All grounding systems present at or above this level within the ATCT shall be connected to this main ground plate. #4/0 conductors inside the shaft shall have the same quantity as external lightning protection down conductors and shall connect to the main ground plate at the base of the ATCT. This base plate shall be grounded via two 500 KCMIL conductor exothermically welded to the base plate and to the EES. The #4/0 conductors shall be routed continuously from the main ground plate to the base plate without sharp bends, loops, kinks, or splices. These conductors shall be exothermically bonded to the main ground plate and the base plate. The #4/0 conductors shall be supported every 3 feet with unistrut on the shaft wall. The connection from the base plate to the EES shall be accomplished in an access well to facilitate periodic inspection. Comply with FAA-STD-19e.

- B. Power Distribution Sources for Tall Towers: All power distribution for the areas at the top of the ATCT shall be via separately derived sources (transformers). These panel boards are served by these transformers shall be grounded in accordance with the requirements of NFPA 70 and the drawing package details. The grounding electrode conductor (GEC) specified in NFPA 70 shall be connected to the grounded and grounding conductors at the first system disconnecting means or overcurrent device. This point of connection is mandated to facilitate the effective installation of a surge protective device (SPD). An SPD rated at 80 kA (8x20 microsecond current waveform) surge capacity or greater, suitable for location category C3 per IEEE C62.41, and providing protection L-L and L-N shall be installed on the load side of the first disconnecting means or overcurrent device of each separately derived system. The ground bus at the first disconnecting means or overcurrent device shall be bonded to the ATCT Junction Level main ground plate established in accordance with the requirements of paragraph above. This connection shall not be in lieu of the grounding electrode conductor requirements of NFPA 70. Grounding electrode conductors shall be installed in PVC conduit.

2.8 ATCT ROOF, STRUCTURAL STEEL, REINFORCING, AND OTHER METAL ELEMENT BONDING

- A. Metal elements such as cab consoles comprising the ATCT shall be bonded together at every console and to the MPG with green insulated #6 at every console. Connections between consoles and Multipoint Group Plates shall use two conductors of different length (see FAA-STD-019e paragraph 4.1.1.3(j) and 4.2.7.4).
- B. Provision shall be made to ensure that all rebar used in tower construction is electrically bonded together by the usual construction steel tie wires – continuous laterally and vertically to the EES – for the entire ATCT. Rebar shall be bonded to the EES with a minimum 2/0 AWG copper conductor that is applied with an exothermic weld.
- C. At the top of the ATCT, the tower cab and all equipment locations supporting the cab shall be enveloped in a rudimentary Faraday cage. This shall be accomplished by bonding together all structural and fabrication steel. In turn, this steel cage shall be bonded to the rebar in the concrete construction with at least four bonding jumpers, 2/0 AWG minimum. Penetrations of the Faraday cage, e.g., conduit, water pipe, etc., shall be bonded to the cage (to any convenient grounded location) at the point of entry - either downward from the roof or upward from the shaft below. Bonding jumpers shall be a minimum 2/0 AWG copper conductor.

- D. At every internal equalization loop, the floors, stairs, walkways, etc. and the elevator support structure at that level shall be bonded to the two ground plates at those locations. All bonding jumpers shall be a minimum 2/0 AWG copper conductor.
- E. The interior metallic piping systems at the top of the ATCT shall be bonded to the main ground plate or to the supplemental ground plate below the cab (Note that this bonding jumper is in addition to NEC requirements).

PART 3 - EXECUTION

3.1 APPLICATION

- A. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated. When these conductors are not sized nor shown on the contract drawings, size them in accordance with NEC 250.122. In no case, however, shall these conductors be smaller than No. 12 AWG. Install green, equipment grounding conductor with all feeder and branch circuit conductors.
 - 1. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.
 - 2. Water Heater, Heat-Tracing, and Anti-frost Heater Circuits: Install a separate equipment grounding conductor to each electric water heater, heat-tracing assembly, and anti-frost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- B. Signal and Communication Systems:
 - 1. Service Locations and Wiring Closets: Terminate grounding conductor on a multiport ground plate.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 - 3. Enclosures: Ground all enclosures of electrical and electronic wiring and distribution equipment in accordance with requirements of NFPA 70.
Facility Level Transient Suppression: Facility level transient suppression components for signal, data, and control lines shall be installed either where the land lines enter the facility or at the demarcation point where the lines transfer to FAA control. See section 26 43 13 "Transient-Voltage Suppression for Low Voltage Electrical Power Circuits" for further details.
- C. Separately Derived Systems: Ground according to NFPA 70 and the contract documents.
- D. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a ground rod with #6 copper conductor in addition to separate equipment grounding conductor run with supply branch circuit.

- E. Connections to Lightning Protection System: Grounding for electrical and electronic equipment shall not be connected to the lightning protection system. See NFPA 780, FAA-STD-019e, and section 26 41 13 of this specification for additional requirements.
- F. Common Ground Bonding shall not be connected to the Lightning Protection System: See Section 26 41 13, "Lightning Protection for Structures."
- G. Grounding Bushing: Provide a grounding bushing for rigid steel conduit entering or leaving a manhole/handhole and all feeder conduit (both ends and at pull/junction box in between). Ground both ends of the rigid conduit from the grounding bushings to the counterpoise using a #2 AWG minimum bare copper cable, or as indicated on the drawings. Provide for power cable and spare conduit. Conduit fittings and joints shall be electrically continuous with bonding resistance of 1 milliohms or less between joined parts.
- H. Grounding bushing, indoors: Provide grounding bushing on all feeder conduits (both ends and junction boxes in between) for power distribution system.
- I. Conduit or Cable Shields: Conduit or cable shields shall not be used as the equipment grounding conductor.
- J. Metallic Non-current Carrying Parts: All metallic non-current carrying parts of electrical and mechanical equipment throughout the facility shall be bonded by welding with a separate equipment grounding conductor, #4 AWG (with green insulation) or larger and connected to the multipoint ground system. All metallic non-current carrying parts of electrical and mechanical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings.

3.2 INSTALLATION

- A. The grounding requirements exceed those of NFPA 70(2017). Grounding system shall be as indicated on the contract drawings and as specified herein. Reference FAA-STD-019e when installing equipment. In no case shall NFPA 70(2017) be violated.
- B. Ground Rods: Install ground rods as follows:
 - 1. Grounding rods shall be as widely spaced as practical, and in no case shall be spaced less than 1 rod length apart. Nominal spacing between rods shall be between 2 and 3 times rod length.
 - 2. Tops of vertically-driven ground rods shall be not less than 12 inches below grade level.
 - 3. Ground rods shall be located 2 to 6 feet outside the foundation or exterior footing of the structure. On buildings with overhangs, ground rods may be located further out.
 - 4. Minimum size = $\frac{3}{4}$ ", 10". Copper or Copper clad steel.
- C. Grounding Electrode Conductor:
 - 1. The grounding electrode conductor shall be bare or insulated copper, and shall be sized as shown in the contract documents. When not indicated in the contract documents, the conductor shall be copper and sized according to NFPA 70(2017), except that the conductor shall not be smaller than #2 AWG. Where the grounding electrode conductor is routed through a metal raceway, the raceway shall be electrically continuous and

bonded to the conductor at each end. The grounding electrode conductor shall be bonded to the earth electrode system with an exothermic-welded joint. For a separately derived system such as a panel board or switchboard downstream of an isolation transformer, the grounding electrode conductor shall be connected in accordance with other parts of this Section. This conductor shall be installed in PVC conduit and terminate by exothermic welding to the closest effectively grounded building steel or as indicated on the drawings.

- D. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact or damage.
- E. Earth Electrode System (EES):
 - 1. Ground rods shall be interconnected by a buried, bare, #4/0 AWG 7-strand copper cable. The cable shall be buried at least 2 feet below grade level. Connections to the ground rods shall be made by exothermic-welding. The interconnecting cable shall close on itself, forming a complete loop, with the ends exothermically-welded. The structural steel of buildings shall be connected to the earth electrode system, as indicated on drawings, with a bare, #4/0 AWG 7-strand copper cable. Connections shall be by exothermic-welds. The grounding electrode conductor for the electric service, sized in accordance with NFPA 70 requirements for grounding electrode conductors, shall be connected to a ground rod in the earth electrode system with an exothermic-weld. All underground metallic pipes and tanks, and the telephone ground, shall be connected to the earth electrode system by a copper cable no smaller than #2 AWG. Where routed underground, interconnecting cables shall be bare. Exothermic-welds shall not be used where hazards exist (i.e., near fuel tanks). In these cases, connections using Contracting Officer's Technical Representative approved pressure connectors will be allowed. Bonding resistance of all interconnections shall be 1 milliohm or less for each bond, when measured with a 4-terminal milliohm meter.
- F. Raceway Grounding:
 - 1. Surface metal raceways, wireways, cable tray, or cable rack systems shall be installed in with short bare copper bonding jumpers installed between adjacent raceway sections to ensure proper bonding. Unless otherwise indicated, the minimum size for these bonding jumpers shall be #6 AWG.
- G. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- H. Interior Metal Piping and Air Ducts: Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- I. Access Wells: Provide for driven grounding electrodes, as indicated. If not indicated, install a minimum of 2 access wells. Set top of well flush with finished grade or floor. For gravel fill, see drawing detail.

- J. Fault Protection: Prevent equipment parts subject to human contact during operation and maintenance from being electrically energized when powering faults or components fail. Ground parts with a low impedance path to the chassis or cabinets in which they are mounted.

3.3 CONNECTIONS

- A. Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series. Make connections with clean, bare metal at points of contact. Coat and seal connections having dissimilar metals with inert materials to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel, for underground connections, ground plates and where indicated on drawings. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Terminations: Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at nonmetallic or nonconductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- D. Raceway Grounding: Surface metal raceways, wireways, or cable tray systems shall be installed in a manner that ensures electrical continuity. Insulated copper bonding jumpers shall be installed between adjacent raceway sections to ensure proper bonding. Uninsulated conductors shall not be used. Unless otherwise indicated, the minimum size for these bonding jumpers shall be #6 AWG. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.
- E. Other Grounding Systems: There shall be no other grounding system in the FAA for electronic equipment besides multipoint ground system (including signal reference grid).
- F. Connections at Access Wells: Connections shall be by exothermic-welds.
- G. Tightening of Connectors: Tighten grounding and bonding connectors and terminators, including screws and bolts, in accordance with torque tightening values specified in UL 486A.
- H. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy "Hyground Connector", Thomas and Betts Compression Connector or FAA approved equivalent equipment when operated at the manufacturer's recommended pressure to develop a minimum force of 12 tons concentric is acceptable as approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in the lightning protection system. See FAA-STD-019e paragraph 4.1.1.2.4.4 for additional requirements.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Handholes: Install driven ground rods and set rod depth so 4 inches will extend above finished floor of handhole. Where necessary, install ground rod before handhole is placed and provide a #1/0 AWG bare, tinned-copper conductor from grounding rod into handhole through a waterproof sleeve in handhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- B. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with #4 AWG minimum, stranded, hard-drawn copper conductors. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Grounding System: Ground pad-mounted equipment and non-current carrying metal items associated with handholes by bonding them to a ground rod in the earth electrode system.
- D. Ground exterior fuel tank (in 2 locations), fuel tank stairs, fuel tank service platform, and fuel tank vent to EES with #4/0 AWG min. copper conductor.

3.5 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Engage an independent electrical testing organization to perform tests described below. Ensure no connection to utility power is made during testing.
 - 1. Tests: Subject the completed grounding system to a test using a fall-of-potential method at system ground well, where a 10 ohm measurement is required. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method in accordance with IEEE 81. Provide COR 7 day notice to witness the tests.
 - a. Earth electrode system ground shall not exceed 10 ohms.
 - b. All grounds, bonds, and continuity tests that fail to meet the minimum standards and resistivity levels as set forth in these electrical specifications shall have their materials removed and replaced and shall have all workmanship redone. If after retesting they fail to meet minimum requirements, the work shall be redone until such work and retesting passes the minimum design parameter requirements.
 - c. All sections of joined conduit, cable tray, or structural steel columns and beams shall have the first 10 consecutive connections of each system tested for continuity/grounding/bonding. If they test within acceptable limits, then test every 10th consecutive connection thereafter. If any test point is higher than specified in these electrical sections then test the next 10 consecutive connections and/or as many points as required to get a satisfactory reading below the specified rating. If more than 10 test points of each system are above the specified values, then all continuity/grounding/bonding points in that system shall be tested.

- B. Report: Prepare test reports, certified by the testing organization of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.6 ADJUSTING AND CLEANING

- A. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 26 05 00, "COMMON WORK RESULTS FOR ELECTRICAL." Maintain restored surfaces.

END OF SECTION 26 05 26

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 REFERENCE STANDARDS

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. ASTM International (ASTM)
 - 1. ASTM A 36 Standard Specification for Carbon Structural Steel
 - 2. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- C. National Fire Protection Association (NFPA)
 - 1. NFPA 70 (2017)..... National Electrical Code
- D. Underwriters Laboratories (UL)

1.3 SUBMITTALS

- A. Product data for each type of product specified.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standards: Components and installation shall comply with NFPA 70 (2017). Electrical components shall be listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 COATINGS

- A. Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Product for use outdoors shall be stainless steel 316. Separate dissimilar

metals with closed cell neoprene tape. See FAA Std 019E 4.1.1.2.3 for metals that require separation.

2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Powder Actuated Fasteners: Not Allowed.
- C. U-Channel Systems: 16-gauge steel channels, with 9/16-inch diameter holes, at not more than 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.
- D. Conduit Sealing Bushings: Factory-fabricated assembly consisting of threaded body and insulating wedging-plug for non-armored electrical cables in conduits subject to exposure to water and/or oil penetration at conduit joints. Provide plugs with number and size of conductor gripping holes as required to suit installation. Construct body of malleable iron casting with hot-dipped galvanized finish. Support systems shall be capable of carrying the weight of the box and its contents.
- E. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts and flat end lock washers. Provide steel channel supports with 9/16-inch diameter holes at not more than 8 inches on center, in at least one surface. Fittings and accessories to mate and match with channels and to be from the same manufacturer.

2.3 FABRICATED SUPPORTING DEVICES

- A. General
 - 1. Shop or Field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with welded spiral seams or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gauge
 - b. 4-inch to 6-inch: 16 gauge
 - c. Over 6-inch: 14 gauge
 - d. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.

D. Supplementary Structural Supports: ASTM A 36 steel shapes.

1. Supports and supporting devices shall be designed and installed to withstand the local code equivalent of a minimum IBC seismic design category C force.
2. Provide the installation of supplementary structural supports required for attachment of hangers and other devices supporting electrical equipment and conduits.
3. Members welded to main structural members shall be equal to the specification for the main structural member.
4. Size support members for their actual loads and safety factors without excessive deflection and with consideration for rigidity under vibration.
5. Provide seismic lateral bracing for all unistrut assemblies, at 20 foot intervals. See drawings for typical details.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NFPA 70 (2017). Coordinate with the building structural system and with other electrical installation.

B. Raceway Supports: Comply with NFPA 70 and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry design load plus 25 percent for future use, multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceway. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceway in accordance with Table I of this Section. Space supports for raceway types not covered by the above in accordance with NFPA 70.
7. Support exposed and concealed raceway within 1-foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or thread-less box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors are carried entirely by the conduit supports with no weight load on raceway terminals.
9. Neither raceways nor boxes shall be fastened to suspended ceiling supports.
10. Cable tray support (uni-strut) shall run the entire length of the Electronic Equipment and Telco Rooms so that the uni-strut is one continuous piece from wall to wall.

- C. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panel boards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- D. Open Overhead Spaces: In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box. Cast metal boxes having thread-less connectors and sheet-metal boxes shall be supported directly from the building structure or by bar hangers.
- E. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceway and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with requirements of Section 07 92 00, "JOINT SEALANTS."
- F. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panel boards, transformers, boxes, disconnect switches, lighting fixtures, and control components in accordance with the following:
 - 1. Fasten by means of wood screws, nails, screw-type nails, carriage bolts, or lag screws of equal holding strength on wood; toggle bolts on hollow masonry units concrete inserts or expansion bolts on concrete or solid masonry; and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - 2. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4-inch in concrete shall not cut the main reinforcing bars. Patch holes that are not used with like and kind materials.
 - 3. Coordinate any cutting or boring of structural beams with Structural Engineer prior to any work being done.
 - 4. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
 - 5. Coordinate with structural engineer on expansion joints used to support raceway.

3.2 TABLE I: SPACING FOR RACEWAY SUPPORTS

HORIZONTAL RUNS			
Conduit size & number of conduits in run		RMC & IMC (1)	EMT (1)
1/2, 3/4 - 1 or 2	Flat ceiling or wall.	5	5
1/2, 3/4 - 1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7

HORIZONTAL RUNS			
1/2, 3/4 - 3 or more	Any location.	7	7
1 & larger	1 or 2 flat ceiling or wall	6	6
1 & larger	1 or 2 where it is difficult to provide supports	10	10
	except at intervals fixed by the building construction		
1 & larger	3 or more any location	10	10
Any	Concealed	10	10
VERTICAL RUNS			
1/2, 3/4	Exposed	7	7
1, 1-1/4	Exposed	8	8
1-1/2 and larger	Exposed	10	10
Up to 2	Shaftway	14	10
2-1/2	Shaftway	16	10
3 & larger	Shaftway	20	10
Any	Concealed	10	10
NOTES:			
(1)	Maximum spacing of supports (feet).		
(2)	Maximum spacing for IMC above apply to straight runs only. Otherwise, the maximums for EMT apply.		
(3)	Maximum support from boxes shall be within 3 feet.		
	Abbreviations:		
	EMT: Electrical metallic tubing		
	IMC: Intermediate metallic conduit		
	RMC: Rigid metallic conduit		
	Maximum: The defined distance or less.		

END OF SECTION 26 05 29

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SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. American National Standards Institute (ANSI)
1. ANSI C80.1 Rigid Steel Conduit, Zinc-Coated
 2. ANSI C80.3 Electrical Metallic Tubing, Zinc-Coated
 3. ANSI C80.6 Intermediate Metal Conduit Zinc-Coated
- C. FAA Standards (FAA)
1. FAA 1217f..... Electrical Work, Interior
 2. FAA STD 019e Lightning and Surge Protection, Grounding,
Bonding and Shielding Requirements for
Facilities and Electronic Equipment
- D. Federal Specifications (FS)
1. WW-C-566..... Conduit, Metal flexible
- E. National Electrical Contractors Association (NECA)
1. NECA Standard of Installation
- F. National Electrical Manufacturers Association (NEMA)
1. NEMA 250..... Enclosures for Electrical Equipment (1000 Volts
Maximum)
 2. NEMA FB1 Fitting, Cast Metal Boxes, and Conduit Bodies,
and Cable Assemblies
 3. NEMA ICS-6 Industrial Control System Enclosure
 4. NEMA OS1..... Sheet-Steel Outlet Boxes, Device Boxes,
Covers, and Box Supports
 5. NEMA RN1 Polyvinyl Chloride (PVC) Externally Coated
Galvanized Rigid Steel Conduit
- G. National Fire Protection Association (NFPA)
1. NFPA 70 (2017)..... National Electrical Code

H. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

I. Underwriters Laboratories (UL)

1. UL 1 Flexible Metal Conduit
2. UL 1242 Intermediate Metal Conduits
3. UL 360 Liquid-tight Flexible Metal Conduit
4. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
5. UL 5 Surface Metal Raceways and Fittings
6. UL 50 Enclosures for Electrical Equipment
7. UL 514A Metallic Outlet Boxes
8. UL 514B Fittings for Conduit and Outlet Boxes
9. UL 6 Rigid Metal Conduit
10. UL 797 Electric Metallic Tubing
11. UL 870 Wireways, Auxiliary Gutter, and Associated Fittings

J. Steel Structures Painting Council (SSPC)

1. SSPC PS-10.01 Hot-Applied Coal Tar Enamel Painting System

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring. Refer to Section 26 05 26, "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS" for related grounding requirements.

1.3 RACEWAY COMPONENTS

- A. All raceway components shall be ferrous. See FAA-STD-019e paragraph 4.2.1.9 on interior lines, conductors, and cables. Raceways include the following:
1. Rigid metal conduit (RMC).
 2. Electrical metallic tubing (EMT).
 3. Flexible metal conduit (FMC).
 4. Liquidtight flexible conduit (LFMC).
 5. Wireway.
 6. Rigid nonmetallic conduit.

1.4 BOXES, ENCLOSURES AND CABINETS

- A. Boxes, enclosures, and cabinets include the following:
1. Device boxes.

2. Outlet boxes.
3. Pull and junction boxes.
4. Conduit bodies.
5. Cable access boxes.
6. Cabinets and hinged cover enclosures.

1.5 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES":
 1. Nonstandard boxes, enclosures and cabinets: Include layout drawings showing components, wiring, supports, and seismic bracing.
 2. Surface raceway
 3. Wireway and fittings
 4. Floor boxes
 5. Hinged cover enclosures and cabinets
 6. Operation and Maintenance Data: Submit in accordance with Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.6 QUALITY ASSURANCE

- A. Comply with the latest edition of NFPA 70 for components and installation. Boxes shall be sized in accordance with NFPA 70 Article 376. Comply with NECA.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "Listed and Labeled" as defined in NFPA 70 (2017) Article 100.
- C. Listing and Labeling Agency Qualifications: A NRTL as defined in 29 CFR 1910.7.
- D. Layout Coordination: Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance and access. All outdoor boxes shall be rated minimum NEMA 3R.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Enclosures shall conform to NEMA standards. All materials procured under this Section shall be in accordance with FAA 1217f and FAA STD 019e.

2.2 METAL CONDUIT AND TUBING

- A. Rigid Metal Conduit (RMC): ANSI C80.1 and UL 6.
- B. Plastic-Coated Steel Conduit and Fittings: NEMA RN1.
- C. Electrical Metallic Tubing (EMT) and Fittings: UL 797 and ANSI C80.3 with compression-type fittings. Screw-type fittings are not acceptable. Use for lighting, building power, fire

alarm, environmental and communication circuits in concealed areas where not subject to physical damage, such as suspended ceilings, furred walls and raised floors. Connectors shall have insulated-throat, smooth bell shaped end. Shall not be used in exterior locations, in concrete, or interior exposed below 8 ft (except in electrical chase).

- D. Flexible Metal Conduit (FMC): Zinc-coated steel; UL 1 and WW-C-566. Conduit and fittings shall be type listed for grounding. Provide FMC in minimum 24 inches or 10 diameter lengths for connection to motors and equipment subject to vibration and movement.
- E. Liquid tight Flexible Metal Conduit (LFMC): Flexible steel conduit with PVC jacket, listed for grounding; UL 360.
- F. Rigid Non-Metallic Conduit: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.
- G. Fittings: NEMA FB1 and UL 514B, compatible with conduit and of the threaded type. Set screw fittings are not allowed. Conduit expansion and deflection fittings shall be watertight. Fabricate from material compatible with conduit to be used. Expansion and deflection fittings shall be equipped with bonding jumper cable to provide electrical continuity. Lock-nut and bushings inside boxes or enclosures shall be grounding type.
- H. Underground Fittings: Shall be protected by field wrapping, 0.01-inch thick pipe wrapping plastic tape applied with 50 percent overlap.
- I. All metal conduits, tubings, and wireways shall be ferrous. See FAA-STD-019e paragraph 4.2.1.9 on interior lines, conductors and cables.

2.3 WIREWAYS

- A. Material: Minimum 16 gauge sheet steel sized and shaped as indicated.
- B. Fittings and Accessories: UL 870. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps and other fittings to match and mate with wireway as required for complete system. Provide ground bushings on all conduit terminations to wireways and galvanized rigid steel as indicated in PART 3 of this Section. Select features where not otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- C. Wireway Covers: Hinged type with screws to close.
- D. Finish: ANSI 49 gray powder finish inside and out over phosphatized surfaces. Provide NEMA rating appropriate for use intended.
- E. All metal conduits, tubings, and wireways shall be ferrous. See FAA-STD-019e paragraph 4.2.1.9 on interior lines, conductors and cables.

2.4 OUTLET AND DEVICE BOXES

- A. Boxes shall not contain concentric knockouts.

- B. Sheet Metal Boxes: NEMA OS1 and UL 514A.
- C. Cast Metal Boxes: NEMA FB1, type FD, cast ferro-alloy box with gasketed cover.
- D. Exposed Outlet Boxes: UL 514A steel, malleable iron or cast iron boxes with threaded conduit entry for surface-mounting in areas having exposed conduit systems.
- E. Flush Outlet Boxes: UL 514A hot-dip galvanized steel, square or rectangular, 2 1/8 inches deep by 4 inches square, with extension ring where necessary.
- F. Boxes for Lighting Fixtures: Flush-mounted or in concealed areas to be octagonal, 4 inches by 2 1/8 inches deep, galvanized steel, with fixture stud supports and attachments to properly support ceiling and bracket type lighting fixtures. Surface-mounted to be malleable or cast iron boxes with threaded conduit hub.
- G. Fittings: UL 514B.
- H. Boxes in concrete shall be cast metal or in exterior locations.

2.5 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS1 and UL 514A.
- B. Cast Metal Boxes: Threaded-hub type conforming to UL 514A and UL 514B. Galvanized steel conforming to UL 514A and UL 514B.

2.6 CABINETS AND ENCLOSURES

- A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and handle. Finish inside and out with manufacturer's standard enamel.
- B. Cabinets: NEMA 250, type 1 code gauge galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard ANSI 49 gray powder finish. Hinged door in front cover with flush latch and concealed hinge. Hinged doors for large enclosures (particularly panelboards) shall have a minimum of a double latch or 4 screws for ease of opening and closing doors. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment. Cabinets shall be constructed with interior dimensions not less than those indicated on the drawings. Provide 5/8-inch plywood backboard unless otherwise indicated. Key latch to match panelboards. Provide two keys with each cabinet unless otherwise notified.
- C. Safety: UL 50.
- D. Control Enclosures: NNEMA ICS-6.
- E. Telephone and Signal Cabinets: Construct in accordance with NFPA 70 Article 312.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected. Examine raceways prior to installation. No crushed or deformed raceways shall be installed.

3.2 WIRING METHODS

- A. Outdoors: Use the following wiring methods:

1. Exposed: RMC, IMC or EMT.
2. Concealed: RMC, IMC or EMT.
3. Underground, Single Run: Concrete-encased PVC 80 with RMC elbows, except last 10' entering a handhole or building shall be concrete-encased RMC and fittings, painted with asphaltic.
4. Underground, Grouped: Concrete-encased PVC 80 with RMC elbows, except last 10' entering a handhole or building shall be concrete-encased RMC and fittings, painted with asphaltic.
5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): LFMC.
6. Boxes, Enclosures: NEMA Type 3R minimum.
7. Disconnects (fused or non-fused): NEMA 3R minimum

- B. Indoors: Use the following wiring methods:

1. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): LFMC.
2. Damp or Wet Locations: RMC.
3. Exposed: RMC and EMT. Rigid metal conduit shall be used when exposed to damage. EMT may be used when not exposed to damage.
4. Concealed: EMT, RMC, MC cable (EMT or MC cable may be used for lighting, receptacles, communications, fire alarm, security and environmental conditions in concealed locations indoors).
5. Boxes and Enclosures: NEMA Type 1, except in damp or wet locations use NEMA Type 3R.
6. Conduit Use: Install RMC, IMC or EMT for all branch circuit panelboard feeders, distribution panel board feeders, transformer feeders, and distribution switchboard feeders. Install EMT for communication, lighting and power branch circuits. USE RMC for all exposed conduit systems within electrical and mechanical equipment rooms and electrical closets from floor level to a height of 8 feet above finished floor. EMT can be used when not exposed to physical damage. Conduit for communications, lighting and power branch circuits may be transitioned to EMT above 8 feet above finished floor.

3.3 INSTALLATION

- A. Products shall be installed in accordance with FAA 1217f and FAA STD 019e. Install raceways, boxes, enclosures and cabinets as indicated, according to manufacturer's written instructions. If there is a conflict between the manufacturer's written installation instructions and FAA 1217f and/or FAA STD 019e, then FAA RE will be the authority having jurisdiction. Minimum size raceway shall be 3/4-inch, unless otherwise noted. Conduit for telephone and signal systems shall be as follows:
1. 3/4-inch conduit may be used for lengths not exceeding 100 feet.
 2. 1-inch conduit shall be used for lengths exceeding 100 feet.
 3. No run shall contain more than two 90 degree bends, or the equivalent.
 4. Provide pull and junction boxes as required to meet the above criteria.
- B. Conduit/Raceway Installation: Conceal conduit including EMT, unless otherwise indicated, within finished walls, ceilings and floors. Raceways shall not be attached to the ceiling suspension system. Raceways shall not be attached to or supported by roof decks. Do not anchor or strap raceways to wall furring channels or to other raceways. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Do not install raceways near uninsulated high temperature services without prior approval of the Contracting Officer's Technical Representative. Install horizontal raceway runs above water and steam piping.
1. Install raceways level and square and at proper elevations. Provide adequate headroom. Conduits and raceways shall run parallel or perpendicular to building structural members.
 2. Install conduit to drain moisture to nearest outlet or pull box.
 3. Inside radii of bends in conduits shall not be less than 6 times the nominal diameter.
 4. No run shall contain more than four 90 degree bends, or the equivalent between conduit terminations.
 5. Signal raceway 2 inches and smaller shall have no run of 1/2-inch or 3/4-inch exceed 50 feet; or 100 feet for 1-inch or larger and a maximum of two 90 degree bends, or the equivalent. Install pull boxes or junction boxes where necessary to comply with these requirements.
 6. Provide conduit bodies, pull and junction boxes required to meet the bends criteria.
 7. Provide a pull box for critical power circuits for three 90 degree bends. Threaded conduit bodies shall be used for all critical power circuits.
 8. Install a pull wire in all empty tubing and conduit systems. Pull wire shall be No. 14 AWG zinc-coated steel or plastic with a minimum 200 pound tensile strength. Provide 10 inches of slack at each end of the pull wire.
 9. Complete raceway installation before starting conductor installation. Raceways shall be fished and swabbed before conductors are pulled.
- C. Support of Raceways: Support raceways and boxes as specified in Section 26 05 29, "Hangers and Supports for Electrical Systems." Boxes for fixtures on suspended ceilings shall be supported independently of the ceiling supports. Boxes shall not be supported from sheet metal roof decks.
- D. Raceway Protection: Use conduit caps to prevent foreign matter from entering raceway. Prevent the lodgment of plaster, dirt or trash in raceways, boxes, fittings, and equipment during construction. Clogged raceways shall be entirely freed of obstructions or shall be replaced. Clean each conduit run before pulling in conductors. Protect stub-ups from damage where

conduits rise through floor slabs. Arrange so curved portion of bends is not visible above finished slab.

- E. Bends and Offsets: Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. IMC bends shall be fabricated with tooling specifically designed for bending IMC. Signal conduit that is 1-inch and larger shall have a minimum inside radii 12 times the nominal conduit diameter. No run shall contain more than four 90 degree bends or the equivalent. Provide pull and junction boxes required to meet the bends criteria. For critical power conduits, only conduit bodies are allowed.
- F. Raceway Fittings: Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated. Screw-type fitting are not acceptable in any application.
- G. Concealed Raceways: Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle third of the slab thickness where practical and leave at least 1-inch concrete cover. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
- I. Raceways in Damp, Concealed or Underground Locations: Raceways or sections of raceways which pass through to damp, concealed, or underground locations shall be of a type allowed for such locations by NFPA 70 (2017) and shall extend a minimum of 12 inches beyond the damp, concealed, or underground area. Grout around conduits. Install duct seal in conduits after wire has been pulled.
- J. Floor and Wall Penetrations: Penetrations through walls or floors shall be sealed to prevent moisture and rodent entry and to deter air transfer. Seal penetrations of walls, which separate individually temperature or humidity controlled areas to prevent air circulation. Type of sealants shall be as specified in Section 07 92 00, "JOINT SEALANTS."
- K. Installation at Structural Members: Install raceways parallel to or at right angles to nearby surfaces of structural members and follow the surface contours as much as practical. Run parallel or banked raceways together, on common supports where practical. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.
- L. Joining of Raceway Fittings: Join raceway fittings designed and approved for the purpose and make joints tight. Use bonding locknuts and bushings at connections subject to vibration. Use bonding jumpers where joints cannot be made tight. Use insulating throat connectors for all conduits to protect conductors where a grounding bushing is not required. Provide expansion fittings for all raceways passing through the building expansion joints and for conduit runs longer than 300 feet.

- M. Terminating: Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- N. Pull Wires: Install pull wires in empty raceways. Use 1,800 pound polyester mule tape for all FAA communication conduits. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200 pound tensile strength for all other conduits. Leave not less than 12 inches of slack at each end of the pull wire.
- O. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded plugs flush with floor.
- P. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Provide #6 AWG stranded insulated green copper bonding jumper terminated on an approved grounding fitting at each end of the flex metal conduit.
- Q. Metal Conduits: Metal conduits shall be mechanically and electrically continuous between outlets, junction boxes and pull boxes, panels, cabinets and similar equipment. Conduits shall enter and be secured to enclosures so that each system is electrically continuous throughout.
- R. Enclosures and Cabinets: Install hinged cover enclosures and cabinets plumb. Support at each corner.
- S. Grounding Connections: Provide grounding connections for raceways, boxes, and components. Sheet metal or self-tapping screws shall not be used for grounding and bonding connections. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A. Provide ground bushings for all feeder conduits at switchgear, switchboards, panelboards, transformers, pull boxes and all other termination points. Where knockouts are used, provide double locknuts, one on each side with a grounding bushing or grounding locknut used on the inside (use grounding bushings on conduit 1-inch and larger).
- T. Field-Cut Conduit: Where conduit has to be cut in the field, it shall be cut square. The cut ends of the field-cut conduit shall be reamed to remove burs and sharp edges.
- U. Field-Threaded Conduit: Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimensions and taper as specified for factory cut threads on conduit.
- V. Boxes: Shall be provided in the wiring or raceway system for pulling wires, making connections and mounting devices or fixtures. Each box shall have the volume required by NFPA 70 (2017) for the number and size of conductors in the box. Label all junction/pull boxes with panelboard name and circuit number with permanent marker.

- W. Outlet Boxes: Each outlet box shall have a machine screw which fits into a tapped hole in the box for the ground connection. Attach boxes to ceilings which are not suspended in at least two places. Distribute lighting fixture load over the ceiling boxes.
- X. Mounting Light Fixtures: Boxes for mounting fixtures shall not be less than 4 inches square and shall be above ceiling or in structure. Provide flex conduit to fixture from box. Conduit shall not pass through light fixture.
- Y. Concealed Wiring: Boxes installed for concealed wiring shall be provided with extension rings or plaster covers. The front edge of the box shall be flush or recessed not more than 1/4-inch from the finished wall surface (whether the finished surface is drywall, or drywall and a sound absorbing material).
- Z. Boxes in Masonry Block or Tile Walls: Shall be square-cornered tile-type, or standard boxes shall have square-cornered tile-type covers.
- AA. Wet Locations: Cast metal boxes installed in wet locations, in concrete and boxes installed flush with exterior surfaces shall be gasketed.
- BB. Mounting: Install switch box on the strike side of the door at mounting height of 48 inches. Unless otherwise indicated, mounting height of receptacle boxes shall be 18 inches. Height of wall-mounted outlet box is defined as the height from finished floor to horizontal centerline of the cover plate. Where outlets are indicated adjacent to each other, mount outlets in a symmetrical pattern with tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets on a vertical line. Verify the final location of each outlet before installation. Remove and relocate outlet boxes placed in an unacceptable position. At fire-rated partitions, offset boxes to prevent back-to-back installation.
- CC. Box Openings: Provide only the openings necessary to accommodate the conduits at the individual location. When this is not practical, plug unused openings.
- DD. Junction, Transition, and Pull Boxes: Install junction, transition, and pull boxes so that covers are not readily accessible. Boxes in concealed areas of ceiling or wall shall be accessible through removable panels. Locate pull boxes to permit easy pulling of wire or cables. Securely attach boxes to structural and framing members using compatible fasteners of adequate size. Bolt wall-mounted boxes to steel profiles fastened to the wall. All boxes shall be labeled with the contained circuits.
- EE. Grounding: Provide each box with a green machine screw. Screw into tapped hole in the box for ground wire or lug connection.
- FF. RMC or IMC Below Slab on Grade or Underground: The conduit shall conform to SSPC PS-10.01 or shall be field wrapped with 0.01-inch thick pipe wrapping plastic tape applied with 50 percent overlay.
- GG. EMT Entering Enclosure Without Threaded Hubs: Provide a connector with threads and cast or machined locknut. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at substantial completion. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer. Cap stubbed up raceways, including raceways in cabinets, immediately upon installation. The use of paper or rag wads is not acceptable.
- B. Galvanic Corrosion Protection: Avoid dissimilar metals in contact anywhere in conduit runs. Where contact cannot be avoided at conduit terminations, treat the connection with joint compound that eliminates galvanic corrosion. Where dissimilar metals are in contact, such as at aluminum cable tray or enclosures and steel supports, separate contact surfaces by using gaskets, non absorptive tape or coating to prevent galvanic corrosion.

3.5 CLEANING

- A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 26 05 33

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

1. This Section included 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; and equipment labels and signs.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. American National Standards Institute (ANSI)
 1. ANSI A13.1 Scheme for the Identification of Piping Systems.
- C. FAA Specifications and Standards
 1. FAA 1217f.....Electrical Work, Interior.
- D. National Fire Protection Association (NFPA)
 1. NFPA 70 (2017).....National Electrical Codes.

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "Submittal Procedures."
- B. Product Data: For each type of product specified.
- C. Schedule of Identification Nomenclature: Provide a schedule of identification nomenclature to be used for identification signs and labels.
- D. Labels and Signs: Samples for each color, lettering style and other graphic representation required for identification materials.
- E. Operation and Maintenance Data: Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

- A. Components and installation shall comply with NFPA 70 (2017). Comply with requirements of ANSI A13.1 with regard to type and size of lettering for raceway and cable labels.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate installing electrical identification after completing of finishing where identification is applied to field-finished surfaces. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials procured and installed in this Section, as well as identification and nameplates shall be in accordance with FAA 1217f.

2.2 RACEWAY AND CABLE LABELS

- A. Manufacturer's Standard Products:
 - 1. Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70 (2017), and these Specifications.
- B. Size: Conform to ANSI A13.1 for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
 - 1. Color: Black legend on orange field.
 - 2. Legend: Indicates voltage and service.
- C. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend is laminated with a clear, weather- and chemical-resistant coating.
- D. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic bands sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
- E. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- F. Underground Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape not less than 6 inches wide by 4 mils thick, compounded for permanent direct-burial service, and embedded continuous metallic strip or core.
- G. Printed Legend: Indicates type of underground line.

- H. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- I. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
- J. Brass Tags: Metal tags with stamped legend, punched for fastener, 2 inches by 2 inches by 0.05-inch thick.

2.3 ENGRAVED NAMEPLATES AND SIGNS

- A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70 (2017), and this Specification.
- B. 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:
 - 1. Engraved Legend: White letters on black face.
 - 2. Punched for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend and size as indicated or as otherwise required for the application. 1/4-inch grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.
- E. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, type 6/6 nylon cable ties with 3/16-inch minimum width; 50 lb minimum tensile strength; minus 40 to plus 185-degree F temperature range; and color as indicated where used for color-coding.
- B. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer.
- C. Arc Flash Hazard- See spec section 260574 for Arc Flash Hazard labeling requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install identification devices according to manufacturer's written instructions. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the contract documents or required by codes and standards. Use consistent designations throughout the project.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- D. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
- E. Painted Identification: Install painted identification as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime surfaces. For galvanized metal use single-component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units use heavy-duty, acrylic-resin block filler. For concrete surfaces use clear, alkali-resistant, alkyd binder-type sealer.
 - 3. Apply one intermediate and one finish coat of silicone alkyd enamel.
 - 4. Apply primer and finish materials according to manufacturer's instructions.
- F. Raceway Identification: Identify raceways with continuous color coded conduit listed below for identification:
 - 1. Colors: As follows:
 - a. Fire alarm system – red.
 - b. Fire suppression supervisory and control system - yellow.
 - c. Security system - orange, no lettering.
 - d. Mechanical and electrical supervisory direct digital control system - blue.
 - e. Telecommunications system - green
- G. Circuit Box Identification Labels: Install circuit identification labels on boxes. Label externally as follows:
 - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover, as well as "permanent magic marker" on inside cover.
 - 2. Concealed Boxes: Plasticized card stock tags, as well as "permanent magic marker" on inside cover.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

4. Underground Electrical Line Paths: During trench backfilling, for exterior underground power, control, signal and communications lines, install continuous underground warning tape located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches, use a single line marker. Install warning tape for underground wiring, both direct buried and in raceway.
5. Color-Code Conductors: The following field-applied color-coding methods may be used in lieu of factory-coded wire listed in Section 26 05 19, "Low-Voltage Electrical Power Conductors and Cables", for sizes larger than No. 4 AWG. Contractor shall demonstrate non-availability of factory-colored wire before using this application:
 - a. 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 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Where conductors are color-coded by this method, they shall be color-coded in accessible raceways, panelboards, outlets, and switches, as well as at all terminations. Conductors in accessible raceways shall be color-coded so that by removing or opening any cover, the coding will be visible.
 - c. Phase, ground, and neutral conductors shall be color-coded in accordance with Section 26 05 19, "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."
 - d. Green insulated conductors shall not be re-identified for purposes other than grounding.
 - e. White or neutral gray conductors shall not be re-identified for purposes other than grounded neutrals.
- H. Power Circuit Identification: Use metal tags for cables, power feeders in pull boxes, junction boxes, handholes, and switchboard rooms:
 1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations and conductor size.
 2. Fasten tags with nylon cable ties; fasten bands using integral ears.
- I. Conductor Identification: Apply identification to conductors as follows:
 1. Conduits and Conductors to be extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number and phase. Use color-coding for voltage and phase indication of secondary circuit.
 3. Multiple Control and Communication Circuits in Same Enclosure: Identify each conductor by its system and circuit designation at enclosure and terminations. Use a consistent system of tags, color-coding or cable marking tape.
 4. Warning, Caution, and Instruction Signs: Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated

- instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
5. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer and other emergency operations.
 6. Equipment Identification: Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Provide equipment, required under Division 26 with nameplate indicating equipment name, system voltage(s), phase, number of wires, fed from which panel, and circuit number. Except as otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1 1/2-inch high label; where 2 lines of text are required, use larger 2-inch high label. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Motor starters.
 - d. Push-button stations.
 - e. VFD's
 - f. Contactors.
 - g. Remote-controlled switches.
 - h. Power disconnects switches.
 - i. Control devices.
 - j. Transformers.
 - k. ATS.
 - l. Power-generating units.
 - m. Telephone switching equipment.
 - n. Fire alarm master station or control panel.
 - o. Security monitoring master station or control panel.
- J. Conduit Labeling: Label conduit at each end and at pull boxes with characters a minimum 1/4-inch high. Each label shall note internal conductor type and other terminal end. Attach labels around conduit for permanent mounting.
- K. Other Components Labeling: Apply identification labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, and similar items for power distribution control components above, except panelboards, and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- L. Manhole and Handhole Cables: Tag cables in each manhole or handhole with not less than two tags per cable, one near each duct entrance hole. Attach tags to cable immediately after installation. Cable terminations shall be tagged as to function. Attach securely to cable using 1/8-inch nylon cord.

- M. Receptacles: Provide self-adhesive plastic with panel name and circuit for each receptacle, located on coverplate.

END OF SECTION 26 05 53

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes various types of receptacles, connectors, multi-outlet assemblies, wall switches, and finish plates.
- B. This Section includes requirements for the furnishing and installing of fire rated wiring devices. Furnish and install all fire rated wiring devices and associated hardware as shown on the Contract Drawings and as hereinafter specified. All devices shall be heavy-duty specification grade with an intumescent insert material allowing for 0 to 100-percent visual fill of conductors. The same manufacturer shall supply all furnished fire rated devices and associated hardware.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
 - 1. Federal Standards (FS)
 - a. FS WC-596 General and Associated Detailed Specifications:
Connector, Plug Receptacle, and Cable Outlet,
Electrical Power
 - 2.
 - 3. National Electrical Manufacturers Association (NEMA)
 - a. NEMA WD-1 General Requirements for Wiring Devices
 - 4. National Fire Protection Association (NFPA)
 - a. NFPA 70 (2017).....National Electrical Code
 - 5. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910.7 Definitions and Requirements for a Nationally
Recognized Testing Laboratory (NRTL)

6.

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."
- B. Product data for each product specified.
- C. Operations and Maintenance Data: Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70 (2017), for devices and installation.
- B. Listed and Labeled: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed. The Terms "listed" and "labeled" are as defined in NFPA 70, Article 100.
- C. Listing and Labeling Agency Qualifications: Listing and Labeling Agency must be a NRTL as defined in 29 CFR 1910.7.
- D. Fire-rated devices shall bear the UL Classification marking. Devices shall be tested in accordance with ASTM E 814 (ANSI/UL 1479).

1.5 COORDINATION

- A. Wiring Devices for Government Furnished Equipment (GFE): Match devices to plug connectors for GFE. Device plates shall be stainless steel, brushed finish. Convenience receptacles shall be ivory; computer receptacles shall be ivory; receptacles for essential circuits shall be ivory; and receptacles for critical circuits shall be orange.
- B. Cord and Plug Sets: Match cord and plug sets to equipment requirements.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

- A. Comply with NEMA WD-1 and UL approved specification grade.
- B. Enclosures: Interior shall be NEMA 1 Equivalent, except as otherwise indicated. Exterior receptacles shall be mounted in waterproof cast outlet boxes with waterproof covers of the extra duty type.

- C. Receptacles: All receptacles shall be specification grade in accordance with NEMA WD-1. Wiring terminals shall be of the screw-type. Receptacles with push-in connections or a combination of screw-type and push-in connectors are not acceptable.
1. Straight-Blade: Except as otherwise indicated, comply with FS WC-596 and Specification Grade of UL 498. Provide NRTL labeling of devices to verify compliance.
 - a. Rated 20 amperes at 125- and 250-volts AC. 125-volt AC receptacles shall have NEMA WD-1 type 5-20R configuration.
 - b. Specification Grade with body of fire resistant non-absorptive thermoplastic material.
 - c. 2-pole, 3-wire grounding type with polarized parallel slots.
 - d. Side wired with two screws for each terminal and one screw for grounding.
 - e. Grounding pole connected to mounting yoke.
 - f. Outlet grounding shall be accomplished by the installation of a #12 AWG green insulated equipment ground conductor from the ground bus in the panel board to the receptacle grounding screw of the receptacle. A green pigtail #12 AWG conductor shall also be installed from the receptacle grounding screw to the grounding lug on the outlet box.
 2. Special Receptacles: NEMA as indicated on drawings.
- D. Weatherproof Receptacles: Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening that can be closed while a device plug is inserted. Provide caps with a spring-hinged flap. Receptacle shall be UL-listed for use in "wet locations" and marked "WR" (Weather Resistant).
- E. Ground-Fault Circuit Interrupter Receptacles: UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices.
- F. Wall Switches
1. Snap Switches: AC switches, NRTL listed and labeled as complying with UL 20 and with FS WC-596. Single-pole and three-way wall switches shall be specification grade, rated 120/277 volts, and shall be fully rated 20 amperes, AC only. Wire terminals shall be of the screw type. Switches with push-in connections or a combination of screw-type and push-in connections are not acceptable. Switches shall be the quiet-operating type. Finish color shall be ivory.
- G. Dimmer Switches: Finish color shall be ivory, except dimmer switches in the ATCT and TRACON shall be black. Refer to Network Lighting Controls 26 09 43.
- H. Fire-Rated Wiring Devices:
1. Cables passing through fire-rated floors or walls shall pass through fire-rated wiring devices which contain an intumescent insert material that adjusts automatically to cable additions or subtractions.
 2. The device (per code requirements) shall include both internal and external firestopping.

3. Cables penetrating through fire-rated floors or walls shall utilize fire-rated pathway devices capable of providing an F rating equal to the rating of the barrier in which the device is installed.
 4. The device shall be tested for smoke leakage (L rating) and shall not require the use of any optional sealing materials to achieve the published rating.
 5. The device shall utilize a fire and smoke sealing system that automatically adjusts to the addition or removal of cables.
 6. Wiring devices shall be capable of allowing a 0 to 100-percent visual fill of cables.
 7. Wire devices shall be of a sufficient size to accommodate the quantity and size of electrical wires and data cables required and shall be suitable for use with new or existing cable installations.
 8. The installed device (in normal use) shall require no maintenance and shall accommodate future cable changes without mechanical adjustment and/or removal or replacement of protective materials.
 9. Wire devices to be provided with steel wall plates allowing for single or multiple devices to be ganged together.
 10. The device shall be modular and shall provide mechanical installation options for common wall and floor constructions as well as common construction conditions including over-sized or damaged openings or existing sleeves.
 11. Acceptable manufacturers shall be EZ-Path Fire-Rated Pathway or approved equal.
- I. Device Plates: Single and combination types that mate and match with corresponding wiring devices. Color and finish as indicated. Features include the following:
1. Plate-Securing Screws: Metal with heads colored to match plate finish.
 - a. Material for Finished Spaces: Brushed stainless steel with beveled edge.
 - b. Material for Unfinished Spaces: Raised type galvanized steel.
 2. Wet Locations: Plates installed in wet locations shall be gasketed.
 3. Telephone and Communications Outlets: Shall be provided with a blank coverplate unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies' plumb and secure, with alignment tolerances of 1/16-inch. Install wall plates when painting is complete. Protect devices and assemblies during painting. Receptacles shall be installed 18 inches above finished floor, unless noted otherwise. Wall switches shall be installed 48 inches above finished floor, unless noted otherwise.
- B. Arrangement of Devices: Except as otherwise indicated, mount flush with long dimension vertical, and grounding terminal of receptacles at bottom. Group adjacent switches under single, multi-gang wall plates. Install switches up or to left for ON position. Mount receptacles in uniform position and same polarity.
- C. Wall Switches: Not more than one switch shall be installed in a single gang position. Where switches have grounding terminals, they shall be grounded with a green grounding pigtail

connected from the switch grounding screw directly to the grounding lug on the outlet box where the green equipment grounding conductor is terminated. Install unshared neutral conductors on line and load side of dimmers according to the manufacturer's written instructions.

- D. Device Plates: Plates shall be installed with all four edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plates installed in wet locations shall be gasketed. Use of sectional type device plates shall not be permitted.
- E. Fire-Rated Wiring Devices:
 - 1. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
 - 2. Apply the factory supplied gasketing material prior to the installation of the wall plates.

3.2 IDENTIFICATION

- A. Comply with Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS." For receptacles identify the panelboard and circuit and number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on both faces of plate and durable wire markers or tags within outlet boxes.

3.3 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

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SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes individually mounted switches and circuit breakers used for feeder and equipment disconnect switches; feeder overcurrent protection; motor disconnect switches; and enclosed circuit breakers.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

- 1. FAA Specifications and Standards

- a. FAA Order 6950.2 Electrical Power Policy Implementation at National Airspace System Facilities.
- b. FAA Order 6950.27 Short Circuit Analysis and Protective Device Coordination Study.
- c. FAA Standard 1217f.....Electrical Work Interior

- 2. Federal Standards (FS)

- a. FS WC-375 Circuit Breakers, Molded Case, Branch Circuit and Service

- 3. International Electrical Testing Association (NETA)

- a. NETA ATS Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

- 4. Manufacturers Association (NEMA)

- a. NEMA AB1 Molded Case Circuit Breakers and Molded Case Switches
- b. NEMA KS1.....Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

- 5. National Fire Protection Association (NFPA)

- a. NFPA 70 (2017).....National Electrical Code

6. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
7. Underwriters Laboratories (UL)
 - a. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

1.3 SUBMITTALS

The following shall be submitted in accordance with 013300 SUBMITTAL PROCEDURES:

- A. Product Data
 1. Switches
 2. Circuit Breakers
 3. Other specified accessories
 4. Include descriptive data and time-current curves; let-through current curves for circuit breakers with current-limiting characteristics. Coordinate charts and tables and related data.
- B. Test Reports
 1. Field Testing
 2. Field test reports indicating and interpreting test results.
- C. Substitutions: Contractor shall submit in accordance with Section 01 25 00 "SUBSTITUTION PROCEDURES"
- D. Certificates
 1. Firms and Persons Qualifications
 2. Qualification data for firms and persons specified in the "QUALITY ASSURANCE" article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Operations and Maintenance Data
 1. Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70 for components and installation.

- B. Testing Agency Qualifications: Independent testing agency shall meet 29 CFR 1910.7 criteria for accreditation of testing laboratories, or shall be a full-member company of the International Electrical Testing Association (NETA).
- C. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in PART 3.
- D. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.
- E. Single Source Responsibility: All enclosed switches and circuit breakers shall be product of a single manufacturer and shall be coordinated with Section 26 00 01, "GENERAL PROVISIONS FOR GOVERNMENT-FURNISHED EQUIPMENT (GFE)."
- F. Listed and Labeled: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled. The terms "Listed" and "Labeled" are as defined in NFPA 70, Article 100.
- G. Listing and Labeling Agency Qualifications: A NRTL as defined in 29 CFR 1910.7.
- H. Available Fault Current: All provided gear from this Section shall be suitable for the available fault current in the area of use.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Provide disconnect switches and breakers by same as GFE vendor.

2.2 DISCONNECT SWITCHES

- A. Switches shall be of heavy duty type and the voltage and current ratings indicated on the drawings, and each shall be capable of interrupting the locked rotor current of the motor for which it is to be used. The locked rotor current will be assumed to be 10 times the full rated load current. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, parts shall be mounted on insulating bases to permit replacement of any part from the front of the switch. All current carrying parts shall be of high conductivity copper unless otherwise specified, and shall be designed to carry rated current without excessive heating. Switch contacts shall be silver tungsten or plated to minimize corrosion, pitting and oxidation and to assure suitable conductivity.
- B. Enclosed, Non-Fusible Switch: NEMA KS1, type heavy duty, lockable handle, with 2 padlocks.
- C. Enclosed, Fusible Switch, Below 800 Amperes: NEMA KS1, type heavy duty, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position. Provide rejection type fuse clips with switches.

- D. Spare Fuses: Provide 2 sets of spare fuses for each fusible device.
- E. Enclosures: NEMA KS1, type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - 1. Outdoor Locations: Type 4X 316 Stainless Steel.
 - 2. Other Wet or Damp Indoor Locations: Type 4X 316 Stainless Steel.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Enclosed, Molded-Case Circuit Breaker: NEMA AB1, lockable handle, with 2 padlocks complying with FS WC-375.
- B. Characteristics: Interrupting rating, frame size, trip rating, number of poles, and auxiliary devices as indicated. Circuit breakers shall have a quick-make and quick-break toggle mechanism, inverse-time trip characteristics and shall be trip-free on overload or short-circuit. Automatic release shall be secured by bi-metallic thermal element releasing the mechanism latch. A magnetic armature shall be provided to trip the breaker instantaneously for short-circuit currents above the overload range. Automatic tripping shall be indicated by a handle position between the manual OFF and ON positions.
- C. Interchangeable Trips: Circuit breakers, 200 amperes and larger, with trip units interchangeable within frame size.
- D. Field-Adjustable Trips: Circuit breakers, 400 amperes and larger, with adjustable, short-time and continuous-current settings.
- E. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.
- F. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- G. Shunt Trip: Where indicated. 120 volts, 60 Hz.
- H. Accessories: As indicated.
- I. Enclosure: NEMA AB1, type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - 1. Outdoor Locations: Type 4X Stainless Steel.
 - 2. Other Wet or Damp Indoor Locations: Type 4X Stainless Steel.
- J. Motor Disconnect: Provide each motor with a disconnecting means and a manually operated switch as shown on the drawings or when required by NFPA 70.
- K. Single Phase Motors: Provide a single-pole or double-pole toggle switch, rated only for AC, for motor capacities less than 30 amperes, providing that the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions. Install disconnect switches and circuit breakers level and plumb. Install wiring between disconnect switches, circuit breakers, control and indication devices. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A. Identify each disconnect switch and circuit breaker according to requirements specified in Section 26 05 53, "Identification for Electrical Systems." Ensure NFPA 70 working space and dedicated electrical space are maintained. Do not install in a location that will violate NFPA 70.

3.2 FIELD QUALITY CONTROL

- A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Visual and Mechanical Inspection:
 - a. Compare nameplate data with specifications and approved shop drawings.
 - b. Inspect circuit breaker for correct mounting.
 - c. Operate circuit breaker to ensure smooth operation.
 - d. Inspect case for cracks or other defects.
 - 2. Electrical Tests:
 - a. Perform contact-resistance tests on each breaker.
 - b. Perform insulation-resistance tests.
 - c. Perform Breaker adjustments for final settings in accordance with Government provided settings.
- B. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, for disconnect switches and for molded-case circuit breakers. Certify compliance with test parameters. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 ADJUSTING

- A. Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish.

END OF SECTION 26 28 16

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SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

1. Electronic Industry Association (EIA/TIA)
 - a. TIA-485.....Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
2. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE 519.....Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
3. International Standards Organization (ISO)
 - a. ISO-9000.....Quality Management and Quality Assurance Standards
4. National Electrical Manufacturers Association (NEMA)
 - a. NEMA 250.....Enclosures for Electrical Equipment (1000 Volts Maximum)
 - b. NEMA ICS2.....Standard for Industrial Control Devices, Controllers and Assemblies
 - c. NEMA KS1.....Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 - d. NEMA MG1 Recommended Motor-Generator Standards
5. National Fire Protection Association (NFPA)
 - a. NFPA 70 (2017).....National Electrical Code
6. Underwriters Laboratories (UL)
 - a. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - b. UL 486B.....Wire Connectors
 - c. UL 508 Industrial Control Equipment

1.2 GENERAL REQUIREMENTS

- A. This Section includes solid-state, PWM, VFDs for speed control of 3-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

- A. IGBT: Integrated gate bipolar transistor.
- B. LAN: Local area network.
- C. PID: Control action, proportional plus integral plus derivative.
- D. PWM: Pulse-width modulated.
- E. VFD: Variable frequency drive.

1.4 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES:"
- B. Shop Drawings
 - 1. For Each VFD
 - 2. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include each installed unit's type and details; nameplate legends; short-circuit current ratings of integrated unit; UL listing for series rating of over current protective devices in combination controllers; features, characteristics, ratings, and factory settings of each unit; complete DDCS system interface documentation including hardware and software. Documentation must clearly demonstrate how VFDs will interface with the DDCS.
 - 3. Wiring Diagrams
 - 4. Power, signal, and control wiring for VFD. Provide schematic wiring diagram for each type of VFD.
 - 5. Coordination Drawings
 - 6. Floor plans showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD layout and relationships between electrical components, and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- C. Product Data
 - 1. For each type of VFD
 - 2. Provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics and finishes.

D. Test Reports

1. Performance tests
2. Submit within 15 calendar days after completion of tests. Provide in accordance with the requirements set forth in paragraph entitled "Field Tests and Inspections". Certify tests were conducted on each converter in accordance with the paragraph entitled "Field Quality Control" and certify converter satisfactorily operated within specified limits. Report shall include copies of the test procedures and test data and results.

E. Certificates

1. Manufacturer Seismic Qualification Certification:
Submit certification that VFDs, accessories, and components will withstand seismic forces defined in Section 23 05 48, "Vibration and Seismic Controls for HVAC Piping and Equipment."
2. Basis of Certification:
Indicate whether withstand certification is based on actual test of assembled components or on calculation. The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
3. Dimensioned Outline Drawings of Equipment Unit:
Identify center of gravity, locate and describe mounting and anchorage provisions. Provide detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Computer Generated Harmonics Distortion Report:
Predict the cumulative Total Harmonic Voltage (THD) and Total Harmonic Current (TDD) generated by the VFDs provided. The computer program shall be provided and supported by the manufacturer of the VFDs. A VFD manufacturer approved technician shall input electrical system information into the program, including, but not limited to transformer KVA and impedance, generator KVA and impedance, short circuit capability, facility loads, cable/wire impedance, VFD configuration, information on existing VFDs, and other information required by the program. The program report shall include a summary of all input data, as well as a summary of the first through 31st harmonics with frequency, percent voltage distortion, percent current distortion, and harmonic current amps for each harmonic. The report shall clearly show that the expected cumulative THD and TDD with all drives operating is less than the limits set in this Section.
5. Startup Personnel Qualifications:
Submit resume listing startup personnel qualifications including manufacturer's certification as an approved system technician and a list of recently completed projects demonstrating 5 years of system startup experience.
6. ISO-9000 Registration:
Provide proof of ISO-9000 registration for the VFD manufacturer.

F. Manufacturer's Field Reports

1. Field Test Reports
2. Written reports specified in PART 3.
3. Load-Current and Overload-Relay Heater List

4. Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 5. Load-Current and List of Settings of Adjustable Overload Relays
 6. Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
- G. Operation and Maintenance Data: Submit in accordance with Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70, NEMA ICS2, and UL 508. VFDs shall be manufactured at an ISO-9000 registered manufacturing facility.
- B. Manufacturer Qualifications: Provide variable frequency drive motor controllers from manufacturers regularly engaged in the manufacture of equipment of the types and capacities indicated, with such products in satisfactory use in similar service for not less than 5 years. Manufacturer must also maintain, within 100 miles of the project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- C. Materials Furnished Under this Division: Shall be standard cataloged products of recognized manufacturers regularly engaged in the production of recognized manufacturers regularly engaged in the production of such material and shall be the latest design. Items necessary for the completion of the work and the successful operation of a product shall be provided even though not fully specified or indicated in each Section.
- D. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Product Selection for Restricted Space: Comply with NFPA 70 and manufacturer's recommended minimum installation clearances between VFDs and adjacent surfaces and other items.
- G. Installation Verification: Upon completion of the installation, a factory authorized service representative shall verify by test and written report, that each VFD is fully functional, installed in accordance with the plans and specifications, and calibrated within the operational limits specified. Acceptable documentation and test procedures shall be as approved on the initial project submittals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Additions to Operation and Maintenance Manuals

- B. Delivery VFDs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Do not store VFDs outdoors.

1.7 COORDINATION

- A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels. Coordinate features of variable frequency drives and control devices with pilot devices, control circuits, and DDCS network interfaces as required in Section 23 09 23 "Instrumentation and Controls for HVAC." Coordinate with Division 23 for requirements of variable speed fans. Ensure that VFDs are compatible with the motors provided. Obtain minimum speed and resonant frequencies of air handling units and program minimum frequency and resonant frequency lockouts to avoid these frequencies. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 WARRANTY OF WORK

- A. The VFD shall be warranted by the manufacturer for a period of 36 months from the date of shipment. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized on-site service.

1.9 EXTRA MATERIALS

- A. Furnish extra materials as described below and in Division 1 that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents. Furnish the quantity indicated, or when a percentage is indicated, a quantity equal to the percentage listed of the number of units installed under this contract, but not less than one. Turn over extra materials to the Contracting Officer's Technical Representative prior to the start of the final acceptance testing.
- B. Spare Fuses: Furnish one spare set of fuses of each type and rating for each VFD installed.
- C. Indicating Lights: Furnish two of each type installed.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

- A. Description: NEMA ICS2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of NEMA MG1, Design B, 3-phase, premium-efficiency induction motor by adjusting output voltage and frequency.

- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection. The motor current shall closely approximate a sine wave.
- C. Output Rating: 3-Phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range unit operating requirements:
 - 1. Input ac voltage tolerance of 460 V, plus or minus 10 percent.
 - 2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
 - 3. Capable of driving full load, under the following conditions without de-rating:
 - a. Ambient Temperature: 0 to 40 degrees C.
 - b. Humidity: Less than 90 percent (non-condensing).
 - c. Altitude: 3300 feet.
 - 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - 5. Minimum Displacement Primary-Side Power Factor: 96 percent.
 - 6. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 - 7. Starting Torque: 100 percent of rated torque or as indicated.
 - 8. Speed Regulation: Plus or minus 1 percent.
 - 9. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
 - 10. Low total harmonic distortion (THD): less than 5%.
- D. Internal Adjustability Capabilities
 - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration: 2 to a maximum of 300 seconds.
 - 4. Current Limit: 50 to a maximum of 110 percent of maximum rating.
- E. Self-Protection and Reliability Features
 - 1. Input transient protection by means of surge suppressors.
 - 2. Snubber networks to protect against malfunction due to system voltage transients.
 - 3. Under- and over-voltage trips; inverter over-temperature, overload, and over-current trips.
 - 4. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 20 performance.
 - 5. Door interlock - When any access door is opened, the interlock circuitry shall open the 60 Hz input device and not allow the input or output device to close. For maintenance purposes, provide a bypass switch to defeat the interlock circuitry.
 - 6. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - 7. Instantaneous line-to-line and line-to-ground over-current trips.
 - 8. Loss-of-phase protection. Control power shall be maintained for a minimum of 5 seconds during a loss of power/phase to prevent nuisance tripping.
 - 9. Reverse phase protection.

10. Under- and over-voltage trips.
 11. Drive over-temperature trip.
 12. Motor over-temperature trip.
 13. Short circuit protection.
 14. Ground fault protection.
 15. Interrupting rating shall be minimum 100,000 amps.
- F. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bi-directional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- G. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- H. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- I. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.
- J. Power Line Noise: Power line noise generated by the VFDs shall be individually and cumulatively limited to a voltage distortion factor and line notch depth as defined in IEEE 519. Comply with the requirements for special applications, as listed in IEEE 519. The total voltage distortion shall not exceed 3 percent. The total current distortion shall not exceed 5 percent. Ensure that line notching and zero crossings are kept within allowable levels on both utility power and on generator power. Provide line reactors, isolation transformers, filters, and chokes as required. When calculating voltage and current distortion for the harmonics distortion report, refer to electrical plans for essential transformer KVA, impedance, voltage, etc. Obtain required data that is not provided on the electrical plans by field verification or obtain directly from the utility company. Existing chiller, pumps and air handling units have a variable frequency drive in operation. The report shall include the combined effects of all VFDs operating in the facility.
- K. Motor Protection: To prevent breakdown of motor winding insulation and to prevent damage to the motor windings and the motor bearings due to circulating currents, limit the rate of output voltage rise over time (dV/dt) to a maximum of 1500 V/microsecond at the motor. Utilize one or both of the following methods:
1. The VFD shall allow the switching frequency to come down to a preset value, which is reached at a predetermined high-speed output frequency.
 2. Provide output line reactors and voltage clamp module consisting of a 3-phase, full wave diode bridge rectifier and dissipating resistors, to reduce motor operating temperature, RFI and EMI. Filters using only inductors, capacitors and/or resistors cannot provide precise clamping of output voltage and are not acceptable.

L. Motor Noise:

Rating (kVA)	Maximum Allowable Acoustical Noise (dBa)
5 - 14	58
5 - 39	62
40 - 99	68
100 - 249	70
250 - Up	72

Motor noise as a result of the VFD shall be limited to 3 dB over across the line operation, measured at 3 feet from the motor's center line.

- M. Full Load Amp Rating: The VFDs full load amp rating shall meet or exceed the requirements of the motor. The VFD shall have a 110 percent overload current rating for 60 seconds and 220 percent overload current rating for 1 second while starting.
- N. Programmable Resonant Frequency Lockouts: The VFD shall have minimum of 4 programmable resonant frequency lockouts with adjustable frequency bandwidths. These lockouts shall be adjusted to match the requirements of the fan or pump controlled by the VFD.
- O. Input/Output Switching: The drive shall be immune to input or output switching. Input or output power may be disconnected while the drive is operating. VFDs without this feature must be interlocked to stop the drive when an input or output disconnect switch is operated as recommended by the manufacturer to prevent damage to the drive.
- P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
 2. Run.
 3. Over-voltage.
 4. Line fault.
 5. Over-current.
 6. External fault.
- Q. Control and Indicating Features
1. Door-Mounted Hand/Off/Auto Switch: In the AUTO position, the VFD shall start/stop from a remote contact closure from the direct digital control system (DDCS). In the HAND position, the VFD shall run regardless of the remote contact position.
 2. Local/Remote Selector Switch: In the remote position, motor speed is determined by signal from the DDCS. In the local position, the motor speed is determined by the manual speed control.
 3. Lost DDCS Signal Reference Speed: When speed control signal from DDCS drops below 50 percent of the minimum signal, the VFD shall switch to default speed control after a selectable time delay. Default speed control shall be user selectable to go to minimum speed; go to maximum speed; go to a preset speed; or to stop. Unless indicated otherwise, each drive shall be initially set to go to a present speed of 50 percent.

- R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. OID feedback signal (percent).
 8. DC-link voltage (VDC).
 9. Set-point frequency (Hz).
 10. Motor output voltage (V).
- S. Control Signal Interface: Provide VFD with the following:
1. The VFD shall accept a 0-10 VDC or a 4-20 mA input speed control signal from the DDCS.
 2. The VFD shall accept a dry contact input for remote start/stop.
 3. The VFD shall accept a dry contact input for the remote safety interlock. Opening this dry contact shall cause the drive to stop in both the drive and bypass modes. The drive shall not restart until manually reset.
 4. Keypad display for local hand operation.
- T. Output Signal Interface: A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
1. Output frequency (Hz).
 2. Output current (load).
 3. DC-link voltage (VDC).
 4. Motor torque (percent).
 5. Motor speed (rpm).
 6. Set-point frequency (Hz).
- U. Remote Indication Interface: A minimum of 3 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
1. Motor running.
 2. VFD operating in contactor bypass mode.
 3. Fault and warning indication (over-temperature or over-current).
- V. Communications: Provide a TIA-485 interface allowing VFD to be used with an external system within a multi drop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via DDCS control. Provide capability for VFD to retain these settings within the nonvolatile memory.
- W. Bypass Controller: NEMA ICS2, full-voltage, non-reversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode. The bypass circuitry shall be mounted in a separate section of the VFD enclosure. The

bypass shall utilize a minimum of 3 contactors to totally disconnect the drive from AC power to allow the drive to be serviced while the motor is running at full speed from line power.

- X. Integral Disconnecting Means: NEMA KS1, fusible switch with lockable handle.
- Y. Auxiliary Contacts: One normally open, one normally closed.

2.2 ENCLOSURES

- A. The VFD and all options shall be housed in a NEMA 1 enclosure, which carries the UL 508 listing label from a UL certified panel shop.
- B. Enclosure Seismic Rating: The enclosure shall be designed to withstand seismic forces in accordance with the requirements of Section 23 05 48, "VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT." Equipment within the enclosure shall be screwed, bolted, or clipped into place to prevent separation of components in a seismic event.

2.3 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push-button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Standard Displays
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- F. Historical Logging Information and Displays
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last 4 faults with time and date stamp for each.
- G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase

reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage with adjustable response delay.

2.4 FACTORY FINISHES

- A. Manufacturer's standard paint applied to factory-assembled and -tested VFDs before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine rough-in for conduit systems to verify actual locations of conduit connections before VFD installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load. Select rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. Anchor each VFD assembly to walls or columns as indicated. Provide steel strut (unistrut) frame at columns. Attach by bolting. Anchors must be selected to support the unit and to withstand the horizontal seismic forces defined in Section 23 05 48, "VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT."
- B. Ensure NFPA 70 working space and dedicated electrical space are maintained during installation of panelboards. Do not install in a location that will violate NFPA 70.

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according to Section 26 05 00, "COMMON WORK RESULTS FOR ELECTRICAL."
- B. Operating Instructions: Frame printed instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices according to Section 26 05 19, "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES." Bundle, train, and support wiring in enclosures. Connect hand-off-automatic switch and other automatic-control devices where available. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position. Connect selector

switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

- A. Conduit installation requirements are specified in Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS." Every raceway entry into a control panel shall be provided with a bushing in accordance with Division 16 requirements. Refer to Section 26 05 26, "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS." for grounding equipment requirements. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. Do not energize the VFDs until the factory trained service representative has performed the initial startup inspection and has verified that the drives can be energized. Follow startup procedures specified under "Placing Systems in Operation".

3.7 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting VFDs. Provide laminated VFD operating instructions and safety procedures and attach to door of VFD.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verification of wire terminations.
 - 3. Installation verification of proper operation of the VFD, motor, and DDCS interface.
 - 4. Verification of motor voltage and frequency, proper control input, and setpoint adjustment of minimum speed, maximum speed, acceleration and deceleration rates, and resonant frequency lockouts.
 - 5. Measure voltages at the output of the drive and at the motor leads to verify that the controller is providing voltage, which does not exceed the maximum voltage allowed by NEMA MG1.
 - 6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with the requirements.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit breaker trip ranges.

3.9 CLEANING

- A. Clean VFDs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain VFDs. Provide three 8-hour training sessions. Course must include safety requirements, basic drive theory, circuit description, operation principles; DDCS interface requirements, installation, maintenance, and troubleshooting. Course shall be provided for three persons in each session. Instructors must be certified by the manufacturer. Equipment installers are not acceptable instructors.

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SECTION 28 31 00 – FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. General

1. The system shall be wired, connected, and left in fully operating condition at the completion of the project. Provide each system complete and ready for operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in strict accordance with the required and advisory provisions of NFPA 72, NFPA 90A and NFPA 70, except as modified herein. Devices and equipment for fire alarm service shall be listed by Underwriters Laboratories Inc. (UL). Where UL listing is not available, FM approval shall be acceptable.
2. The work performed pursuant to these specifications shall be complete in every respect, resulting in a system installed in accordance with the applicable codes, standards, manufacturer's recommendations, and UL listings.

B. Equipment

1. The Contractor shall provide all devices, equipment, raceway, wiring and labor as required herein necessary to provide a complete new approved fire detection and alarm system; consisting of but not limited to:
 - a. Duct type smoke detectors.

C. Other Services Required Under This Specification Include:

1. Prepare and submit shop drawings, contractor record drawings and other submittals required herein, within the time frames noted.
2. Warranty all new equipment and systems for one year after the date of final acceptance of the system by the FAA as required herein.
3. Upon completion of this work, the FAA shall be provided with:
 - a. Complete documentation of system testing as described below.
 - b. Certification of minimum one-year warranty.

1.2 REFERENCES – SEE DIVISION 1

1.3 QUALITY ASSURANCE

A. Contractor Qualifications

1. All unused raceways shall be demolished unless directed otherwise by the RE. All areas where portions of the existing fire alarm system are removed shall be repaired to match the surrounding areas. All repairs shall be subject to approval by the RE.

B. Delivery and Storage - See Division 1.

- C. Removal of Debris - See Division 1.
- D. Contractor Proposed Alternatives - See Division 1.

1.4 SUBMITTALS

- A. General – See Division 1.
- B. Quality Assurance
 - 1. The Contractor shall submit with his bid, for review and acceptance, a list of Technicians who will be on-site or have a level of responsibility and involvement with this project. A copy of each Technician's NICET Certification and manufacturer's training certificate for the system to be installed shall be included with the submittal documents. This information shall be provided with the first submittal.
- C. Subcontractors
 - 1. Any electrical subcontractor(s) shall:
 - a. Hold all licenses and permits necessary to perform this work.
 - b. Have at least five (5) years of experience in the installation of systems of this type.
 - c. Have worked on five or more large, fire alarm system installation projects in the last five (5) years. Names, locations, contacts, and phone numbers for five (5) of these projects shall be provided with the submittals.
- D. Equipment Lists – see Division 1
- E. Work Schedule – see Division 1
- F. Permits, Licenses, and Certificates – see Division 1
- G. Installation Phasing Plan or (Transition Plan) – see Division 1
 - 1. The phasing plan shall indicate the schedule for installation of all new devices and removal of existing devices. Special attention shall be made to the use of existing raceway for new wiring (after approval of the RE), while maintaining existing wiring currently in service.
 - 2. The Contractor shall obtain final approval of the Installation Phasing Plan from the RE prior to commencement of any work.
- H. Shop Drawings and system component data sheets – see Division 1
 - 1. The submittal shall include manufacturers' data sheets showing the types and models of all equipment, devices, material, and wire/cable proposed. Evidence of UL listings and local approvals shall be submitted with the data sheets.
- I. Operation and Maintenance Manual

- a. Manufacturer's data sheets and installation and operating manuals/instructions for all equipment installed with detailed inspection, testing, maintenance, and troubleshooting instructions for each specific type of trouble condition recognized by the system, including open circuits, short circuits, ground fault, parity errors, "loop failures", dirty device, etc. When a data sheet shows more than one product, the proposed product shall be clearly indicated by arrows or other suitable means. These instructions shall include a list of all trouble signals annunciated by the system, a description of the condition(s) which will cause those trouble signals, and step-by-step instructions describing how to isolate those problems and correct them (or call for service, as appropriate).
- b. A list of spare parts provided including type device and model number.
- c. Manufacturer's published wire/cable installation guideline including recommended wire types.
- d. Provide a full copy of the warranty.
- e. Completed Inspection and Test Report and Record of Completion.
- f. Manufacturer's Owner's Manual.

J. Contractor Record Drawings (As-Built)

1. The Contractor shall provide and maintain on the site an up-to-date record set of approved shop drawing prints which shall be marked to show each, and every change made to the fire alarm system from the original approved shop drawings. This shall not be construed as authorization by the FAA to deviate from or make changes to the approved shop drawings without written instruction from the FAA in each case. This set of drawings shall be used only as a record set. These drawings shall be made available to the RE, or other FAA representative at each scheduled construction meeting and upon request.
2. The Contractor record drawings are required to show and to identify the location and quantities of junction boxes, terminal boxes, spare conductors, color coding of conductors, splices, device backboxes, and terminal strips. These drawings shall include a schedule of all connections/terminations, indexed by junction box, device backbox and terminal strip and shall reference wire identification taped numbers as installed at each termination or interconnection.
3. Upon completion of the work, the record set of prints shall be used to prepare complete, accurate final record drawings reflecting any and all changes and deviations made to the fire alarm system. The Contractor shall submit two (2) draft copies of record drawings to the FAA for review at least seven (7) calendar days prior to the CAI

K. Test Record

1. System certification and documentation of system testing required by other sections of this specification shall be submitted to the RE for review and approval – see Division 1.

1.5 WARRANTY / SERVICE PERIOD

A. Warranty Period

1. The Contractor shall warranty all materials and workmanship during the installation period and a period of one (1) year, beginning from the date of final acceptance by the FAA (immediately after the Contractor Acceptance Inspection, or Combined CAI/ JAI). The Contractor shall be responsible during the design, installation, testing and warranty periods for any damage caused by him or his subcontractors or by defects in his or his subcontractors' work, materials, or equipment.

1.6 SPARE PARTS

- A. The Contractor shall supply, as part of the contract, the spare parts in new condition, in original, unopened boxes, with installation guides. Spare parts shall be the same models as those installed in the system. Provide spare parts fourteen (14) days prior to the CAI.
 1. Automatic Detection Devices - This includes smoke detectors, heat detectors and duct smoke detectors. Two percent of the installed quantities or each type but not less than two (2) of each type.

1.7 SPECIAL TOOLS

- A. Special Tools – see Division 1
 1. The Contractor shall supply as a part of the contract, three (3) complete sets of any special tools necessary for normal operation and maintenance of the system.

1.8 FINAL APPROVAL AND ACCEPTANCE

- A. Final approval and acceptance of the work will be given by the FAA following a successful CAI. This shall include the observation of complete system inspection and testing per this specification, and approval in writing by the FAA. All required submittals shall have been provided to, reviewed, and accepted in writing by the FAA including:
 1. System operation and maintenance manuals.
 2. Warranties.
 3. System Certification
 4. System test reports.
 5. Spare parts.
 6. Special tools.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Listed Equipment

1. All equipment and system components furnished and installed shall be new and listed by UL for their intended use. The equipment and system components shall be installed in accordance with the applicable codes and standards, the manufacturers' recommendations, and within the limitations of the UL listings.

B. EMI/RFI/AC Voltage Interference

1. All fire alarm control equipment, devices and wiring shall be protected against unwanted radiated electromagnetic interference (EMI) and radio frequency interference (RFI) or induced voltages caused by AC power circuits, electrical transformers, motors or switchgear, electronic equipment, fluorescent lighting fixtures, hand held portable radios, cellular phones or other devices which can interfere with normal system processing and possibly cause unwanted alarms.
2. The system shall be designed and installed to be unaffected by the operation of a hand-held portable radio (walkie-talkie) of 5 watts (maximum) power generating capability and handheld cellular telephone within 12 inches of any system device with all appropriate covers installed.

2.2 SMOKE DETECTORS

A. Duct Smoke Detectors

1. Acceptable duct smoke detectors include:
 - a. Edwards System Technologies
 - 1) SIGA-DH
 - b. Notifier
 - 1) InnovairFlex
 - c. Siemens Fire Safety System
 - 1) AD-HR
 - d. SimplexGrinnell LP
 - 1) 4098-9755
2. Calculations or measurements of air velocities shall be provided to ensure duct detectors are installed within their UL listed range of airflow and placed appropriately to achieve required air stream sampling.
3. Operation of duct smoke detector shall be annunciated as a supervisory condition.

2.3 REMOTE ALARM LED'S

- A. Remote alarm LEDs shall be provided where the alarm indicating LED on any initiating device is not viewable from the floor. The remote LED shall illuminate when the associate device is in alarm.
- B. All remote alarm LEDs shall be clearly and permanently labeled with engraved plastic tags with, 5/8-inch white letters on red background. Labels shall identify the type and system address of its associated device(s) and the device location (i.e., room number).

PART 3 - EXECUTION

3.1 INSPECTION

- A. The job site supervisor shall examine daily all areas in which the work will be performed on the day prior to beginning work. The supervisor shall immediately report unsatisfactory working conditions to the RE for resolution. The supervisor shall not proceed with the work until all unsatisfactory working conditions have been corrected.

3.2 INSTALLATION

- A. Provide and install the system in accordance with the plans and specifications, all applicable codes, and the manufacturer's recommendations. All wiring shall be installed in raceway and comply with all the provisions of NFPA 70, NFPA 72, and FAA criteria. Upon completion, the Contractor shall so certify in writing to the FAA. The following shall be included in the work:
 - 1. Wiring (conductor and cable) color code (as indicated in Part II) shall be maintained throughout the installation. A wiring color code key shall be permanently attached to the inside of the fire alarm cabinet.
 - 2. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with other contractors. Locations of all equipment, controls and system components are subject to the approval of the FAA.
 - 3. All holes made by the Contractor in any wall, ceiling or floor shall be patched by the Contractor, restoring the walls, ceilings, floors to their original condition of fire resistance and integrity as required by other parts of this Specification and applicable codes.
 - 4. All piping and raceway shall be installed at a height so as not to obstruct any portion of a window, doorway, stairway or passageway, and shall not interfere with the operation of any mechanical or electrical equipment.
 - 5. Contractor is responsible for protecting smoke detectors during construction. These detectors shall be covered during construction. All such covers shall be removed upon completion of work.
 - 6. All systems, components, equipment, devices, conductors, and other fire protection appurtenances shall be installed and dressed in a workman-like manner, so as to maintain such equipment readily identifiable, accessible and serviceable. Any equipment not installed in this manner will be replaced and reinstalled at the Contractor's expense and to the satisfaction of the FAA.
- B. Circuit Configurations
 - 1. "T-tapping" shall not be permitted on any fire alarm circuits.
 - 2. Signaling Line Circuits
 - a. The wiring between addressable devices (including connection of annunciation devices) shall be Class A (Style "6" or "7").
 - 3. Duct smoke detectors

- a. Sampling tubes shall extend across the full width of the duct. The ends of the sampling tubes shall be accessible from outside the duct and shall be sealed with removable plugs (to facilitate detector testing). Sampling tubes shall be perforated type. Slot type sampling tubes shall not be acceptable. A short pick-up tube not extending across the widest dimension of the duct shall not be acceptable. Access hatches shall be provided for each sampling tube to allow inspection, cleaning, and maintenance of the entire assembly, without tube removal. Access hatches shall also be provided, where necessary to entrain smoke into the airstream for detector testing. Hatches shall be sufficient size but never less than 8-inches by 8-inches. Refer to NFPA 72 and NFPA 90A for guidance.
- b. Provide necessary interface wiring to fan and air-handling unit or MCC (motor control center) panels for shutdown of fans when smoke is detected and/or smoke control mode operation.
- c. Termination Methods
 - 1) All circuit runs shall be continuous between devices, without splices, wherever feasible. Where a continuous run is not feasible, connections shall be made in a UL listed metal electrical box. Wire nuts shall not be permitted. All connections shall be to mechanically mounted terminal blocks, which are permanently mounted in metal enclosures. All terminal blocks shall conform to the requirements of Chapter 3 of NFPA 70. All conductors forming a circuit shall have the same color and type insulation. All connections shall be accessible for inspection and service and shall be clearly identified with a permanent approved wire label and noted on the Contractor record drawings. Conductors looped around terminals are also not acceptable.
 - 2) Each conductor termination shall be uniquely identified with tags at both ends. The wire tags shall be computer generated printed labels. These tags shall indicate the wire/cable functions i.e., “XX Floor Horns”, “XX Floor Strobe”, “XX, XX, XX, Addressable Loop”, and etc. The conductors shall be tagged at every termination, including all panel, device, and necessary terminal block terminations. These conductor numbers shall be shown on the Contractor's record drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of all conductor terminations.
 - 3) All conductors shielding shall be continuous (with approved interconnections in terminal cabinets) for the length of the circuit, grounded at the associated control unit only. Shield foil shall be terminated in accordance with manufacturer’s recommendations.
- d. Raceways (including electrical enclosures, junction boxes, pull-boxes, and device back-boxes)
 - 1) All fire alarm system raceways, junction boxes, pull boxes, terminal cabinets, electrical enclosures, and device backboxes shall be readily accessible for inspection, testing, service and maintenance.
 - 2) All raceways shall be grounded by approved ground clamps or other means in conformance with NFPA 70 and FAA Orders.
 - 3) Location of raceways

- a) All fire alarm raceway arrays shall be routed and installed to minimize the potential for physical, mechanical or by fire damage, and so as not to interfere with existing building systems, facilities, or equipment, and to facilitate service and minimize maintenance.
 - b) All fire alarm system raceways shall be installed at a height so as not to obstruct any portion of a window, doorway, stairway, passageway, or workspace, and shall not interfere with the operation of or access to any existing mechanical or electrical equipment.
 - c) All fire alarm system raceways shall be routed/installed either parallel or perpendicular to building structural members.
 - d) Raceways, junction boxes, panels, electrical enclosures, relays, and device backboxes shall be exposed in unfinished areas and concealed in walls, ceiling spaces, electrical shafts or closets, in finished areas, except as noted on the drawings.
 - e) All wire, cable, raceways, junction boxes and device backboxes shall be concealed in walls, ceiling spaces, electrical shafts, or closets in all finished areas. Raceways, junction boxes and device backboxes may be exposed in unoccupied areas or mechanical equipment rooms.
- e. All fire alarm raceways, except flexible conduit whips to devices, shall be solidly attached to building structural members, ceiling slabs or permanent walls. Raceways shall not be attached to other raceway, duct work, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, evacuation signaling or auxiliary function devices.
 - f. Bushings shall be provided at the termination of all raceways.
 - g. Junction boxes shall be installed as necessary to minimize the overall length of raceway required, consistent with these Specifications. All conductors shall be pulled through junction boxes, without splices.
 - h. Pullboxes shall be installed in each fire alarm system raceway at intervals not to exceed 100 feet. Pullboxes shall be 4-inch square, minimum.

3.3 TESTING

A. System Tests

1. All system testing shall be scheduled with the RE. The Contractor shall post suitable signs at least 24 hours prior to and shall maintain during testing which indicate the date and time fire alarm testing is to occur. The signs shall be located in lobbies, elevator lobbies and other suitable locations deemed suitable by the RE so as to notify occupants of the testing. All system testing shall be conducted as per the requirements of NFPA 72.
2. Contractor shall provide the FAA with written certification that the installation, operation, and performance of all equipment has been inspected and tested and approval documented by a signature of a manufacturer's authorized representative. The manufacturer's authorized representative shall specifically document approval of the system, equipment, devices, components, and program software are in accordance with applicable codes, the manufacturer's recommendations, and UL Listings, and is in proper working order.
3. The Contractor shall perform a pre-acceptance test to ensure system operation and compliance with the referenced codes and this specification. A completed NFPA 72 Inspection and Testing form shall be submitted to the RE, with written request to schedule a CAI in accordance with Division 1.

B. Acceptance Testing

1. Upon completion of the installation and prior to the CAI, the Contractor shall perform and document, in an approved format, system tests as required herein. All acceptance tests shall be performed in the presence of the FAA or its designated representatives.
2. The Contractor shall provide all materials, equipment, coordination, and personnel necessary to perform and document all required tests. All test equipment shall be subject to the approval of the RE. Fire alarm systems and other systems and equipment that are associated with fire alarm systems and accessory equipment shall be tested accordance with NFPA 72.
3. Fire Alarm system smoke detectors shall have a sensitivity test performed as part of the acceptance test. The sensitivity testing shall be conducted as described below and recorded by the contractor.
 - a. Detector sensitivity shall be checked after installation.
 - b. To ensure that each smoke detector is within its listed and marked sensitivity range, it shall be tested using any of the following methods:
 - 1) Calibrated test method
 - 2) Manufacturer's calibrated sensitivity test instrument
 - 3) Listed control equipment arranged for the purpose
 - c. Detectors found to have sensitivity outside the listed and marked sensitivity range shall be replaced.
4. The detector sensitivity shall not be tested or measured using any device that administers an unmeasured concentration of smoke or other aerosol into the detector.

C. Final Inspection and Acceptance Tests

1. The Contractor shall arrange with the FAA for final inspection and witnessing of the final acceptance tests. The FAA will witness the final acceptance test. The Contractor shall provide at least fifteen (15) working days written notice for all tests or as otherwise specified herein.
2. If the operation of a device, circuit, control unit function, or special hazard system interface is simulated, it shall be noted on the certificate that the operation was simulated, and the certificate shall indicate by whom it was simulated.
3. At the completion of all testing defects and malfunctions shall be corrected. If a defect or malfunction is not corrected at the conclusion of system inspection, testing, or maintenance, the FAA's designated representative shall be informed of the impairment in writing within 24 hours with written explanation addressing the contractor's proposed corrective measures.
4. Failure of all or part of the Final Acceptance Test shall invalidate the Contractor's System Certification, in which case re-certification (including 100% Contractor retesting) and a repeat of the Final Acceptance Test shall be required at no additional cost to the FAA.
5. The Contractor shall provide the FAA with a completed and signed NFPA 72 Inspection and Testing Form and the NFPA 72 Record of Completion Form or Contractor Equal, and record drawings at the successful completion of the Construction Acceptance Inspection (CAI).

PART 4 - EQUIPMENT INFORMATION

- A. The Contractor shall state the quantity and model numbers of devices proposed in the Base Bid. The Contractor is responsible for providing the FAA with a complete fire alarm system, in accordance with the specifications, for the contract price.

<u>Device Type</u>	<u>Quantity</u>	<u>Model No.</u>
1. Duct smoke detectors		

PART 5 - CONTRACTOR'S SUBMITTAL CHECKLIST

- A. Below is a list of submittals and documentation that is required for the installation of the fire alarm system. This is provided for the Contractor's information only and is not an all-inclusive list. This list indicates major submittals and other documentation required as part of this specification. The Contractor is responsible for all submittals and documentation required as part of this specification.

<u>Item</u>	<u>Specification Reference</u>	<u>Due</u>
1. Certifications and Qualifications	1.5-B	With bid
2. Subcontractors	1.5-C	With bid
3. Equipment Information	1.5-D	With bid
4. Work Schedule	1.5-E	With bid
5. Permits	1.5-F	Prior to start of installation
6. Installation Phasing Plan	1.5-G	Within 30 days of authorization to proceed
7. Shop Drawings	1.5-H	In accordance with work schedule

END OF SECTION 28 31 00